DOCUMENT RESUME

ED 081 174 EM 011 260

AUTHOR	Smith, M. Daniel
TITLE	Learning Difficulty, Transfer, and Retention as Functions of Two Types and Two Levels of Redundancy in a Sequence of Concept Formation Tasks in Mathematics Involving Computer Assistance. Final Report.
INSTITUTION	New Hampshire Univ., Durham.
SPONS AGENCY	National Center for Educational Research and Development (DHEW/OE), Washington, D.C. Regional Research Program.
BUREAU NO	BR-1-A-050
PUB DATE	Mar 73
GRANT	OEG-1-71-0018(509)
NOTE	135p.
EDRS PRICE	MF-$0.65 HC-$6.58
DESCRIPTORS	*Computer Assisted Instruction; Computer Graphics; Concept Formation; *Educational Research; Elementary School Students; Learning; *Mathematical Concepts; Mathematics; Programed Instruction; Redundancy; *Retention; Testing; *Transfer of Training

ABSTRACT

Research employed two types of redundancy, each having two levels, at each stage of a programed sequence of non-verbal concept learning tasks. One type involved amount of variation and repetition of exemplars; the other, strength of feedback. A researcher presented tasks to 4th, 5th, and 6th graders, simulating a computer graphic display. The stimuli involved two-dimensional vectors, and the subjects' responses were identifications of points in two-space. Responses were input to a computer and feedback provided to subjects, with subsequent graphic demonstration of correct responses. Criteria were: a) number of responses to reach two successive correct answers during learning; b) immediate post-test performance; and c) performance on a delayed post-test. Evaluation noted some minor differences during learning, particularly with respect to response latency. No significant differences were noted on immediate post-tests, but delayed post-test data suggested an optimal level for both types of redundancy and also an interaction effect, which in turn suggests there is an optimal combination of the two types. (Author/PB)

FILMED FROM BEST AVAILABLE COPY

ED 081174

EM

Final Report

Project No. 1A050
Grant No. OEG 1-71-0018(509)

M. Daniel Smith
University of New Hampshire
Morrill Hall
Durham, N.H. 03824

LEARNING DIFFICULTY, TRANSFER, AND RETENTION AS FUNCTIONS OF TWO LEVELS OF REDUNDANCY IN A SEQUENCE OF CONCEPT FORMATION TASKS IN MATHEMATICS INVOLVING COMPUTER ASSISTANCE

March, 1973

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education

National Center for Educational Research and Development
(Regional Research Program)

This is the best copy available of a document processed for EDRS by ERIC/EM. We are aware that some pages may not be readable in microfiche or hard copy. However, we feel that the document shouldn't be withheld on the basis of these pages alone.

EM 011 260

Author's Abstract

Two types of redundancy, each having two levels, were employed at each stage of a programed sequence of concept-learning tasks. These tasks were purely iconic (i.e. non-verbal). One type of redundancy involved amount of variation and repetition of exemplars; the other involved strength of feedback. The number of exemplars was ten for each stage. The tasks were presented by a research assistant, who simulated a graphic computer display. The stimuli involved two-dimensional vectors, and Ss response was identification of a point in two-space. Response was translated into a computer input by the RA, and the computer terminal gave S feedback as to correctness. Subsequently, the correct response was demonstrated graphically. Criteria were (a) number of responses to reach two successive correct, during learning, at each stage, (b) performance on immediate post-tests, and (c) performance on a delayed (six month) post-test. Students in the fourth, fifth, and sixth grades of local schools were the subjects. Some minor differences were noted during learning, particularly in respect to time required to respond: latency, however, was not recorded objectively. No significant differences were noted on immediate post-tests. Delayed post-test data suggest an optimal level for both types of redundancy, also an interaction, which in turn suggests existence of an optimal combination of the two.

Final Report

Project No. 1A050
Grant No. OEG 1-71-0018(509)

LEARNING DIFFICULTY, TRANSFER, AND RETENTION AS FUNCTIONS OF TWO TYPES AND TWO LEVELS OF REDUNDANCY IN A SEQUENCE OF CONCEPT FORMATION TASKS IN MATHEMATICS INVOLVING COMPUTER ASSISTANCE

M. Daniel Smith

University of New Hampshire

Durham, N.H. 03824

March, 1973

The research reported herein was performed pursuant to a grant from the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education

National Center for Educational Research and Development
(Regional Research Program)

Introduction

Inductive or discovery teaching is an accepted strategy. Teaching through purely iconic (non-verbal) tasks is not as well known, but basic research in concept learning has demonstrated its feasibility in the laboratory, and this project demonstrates its practicability in a school setting.

Whether one teaches purely by example, or by rule followed by examples, one faces a decision as to how much variety to present the student. He also faces the problem of how much information to give him about his "solution" or way of finding the answer. This study explores both of these variables. Theoretically, they are both forms of redundancy, i.e. the degree of order and simplicity used in the teaching tasks. They can also be seen as degrees of guidance, i.e. the more repetition and the more information given the learner about his response, the more guidance he has received.

This project also explores the use of a computer in storing data concerning responses, in presenting feedback to the learner, and in interpreting a non-verbal response (identification of a point in space). The graphic equipment needed for the latter was difficult to locate: a research assistant simulated this potential computer function, while a search for appropriate hardware was conducted. The simple requirement (interactive processing of a position-in-space response) turned out to have major ramifications.

Research on discovery learning suggests that it has advantages for transfer. The post-tests in this study included problems requiring transfer. Studies by Brant and Berg, Morrisett and Hovland, and Kendler, and Vineberg have indicated that varying the number of consecutive confirmations given before transfer will have significant effects on transfer: here, variation involves the number of different tasks confirmed, rather than the number of confirmations per se, which was held constant.

Procedure: Wordless, iconic tasks were presented on $8\frac{1}{2}$ by 11 paper, calling for S to identify a point on the paper as the "answer", i.e. the final position of a point which is translated by the arrow (the two dimensional vector). (See Figure 1.) As the sequence progresses, with ten examples (tasks) at each stage, S discovers vector addition, inverse, and scalar multiples. This is translated into addition of directed numbers.

The ten tasks at each stage are presented in two ways, i.e. as five repetitions of two different examples of the task, or two repetitions of five different examples. These are the two levels of variation. At the same time, there are two levels of feedback: in one, the final point is indicated to S on a facsimile of the original task sheet; in the other, the final point is supplemented by a dotted path indicating the manner in which the point moved according to the vector given. (See Figure 2) Tasks are illustrated in the Appendices, also the nature of the feedback from the computer.

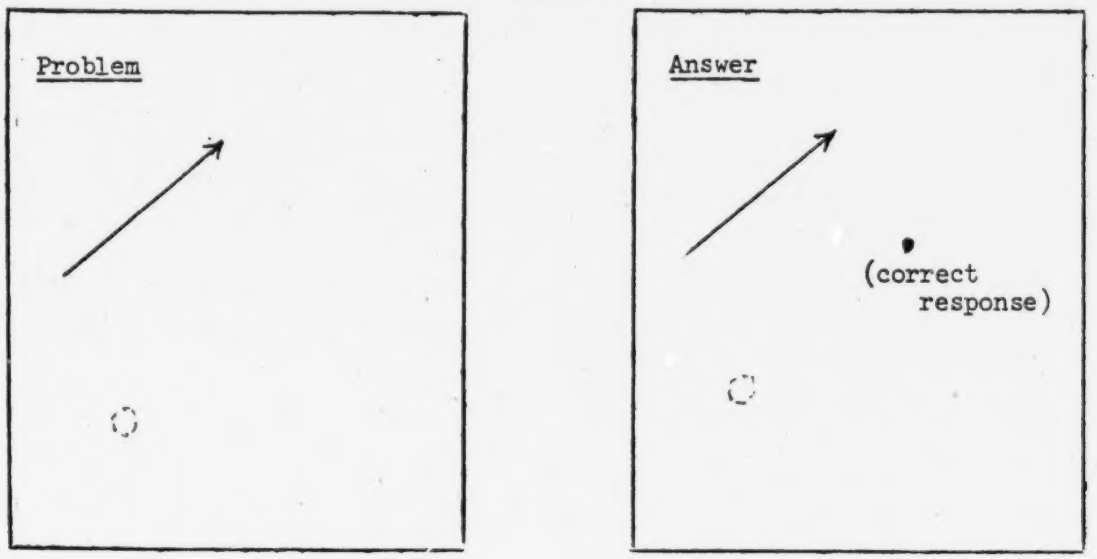
The original plan was to present the task via graphic display, and have a computer evaluate the response and give feedback. Due to difficulties in obtaining the necessary instrumentation, a research assistant substituted for the graphic display. The student indicated a point on the answer sheet, and the assistant fed this information into the computer using a numerical code. The computer then printed (for the S) the words "right on", or "close", or "way off".

This was done so that (a) a completely computerized self-instructional approach could be simulated and explored and (b) the data could be stored in the computer memory for future retrieval for data processing. The key capability needed with a graphic display is one where the S can point to a point on the display and have the computer interpret this as correct, nearly correct, or incorrect, and then feed that information back to the S verbally (via print-out

Figure 1

Stage 1, Tasks 1 and 2

Task 1



Task 2

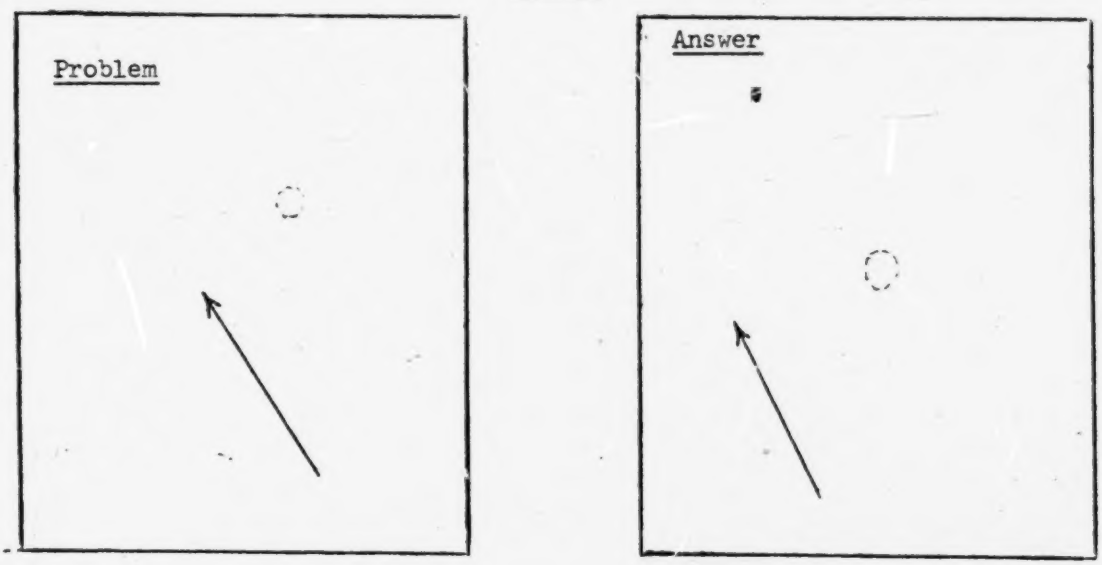
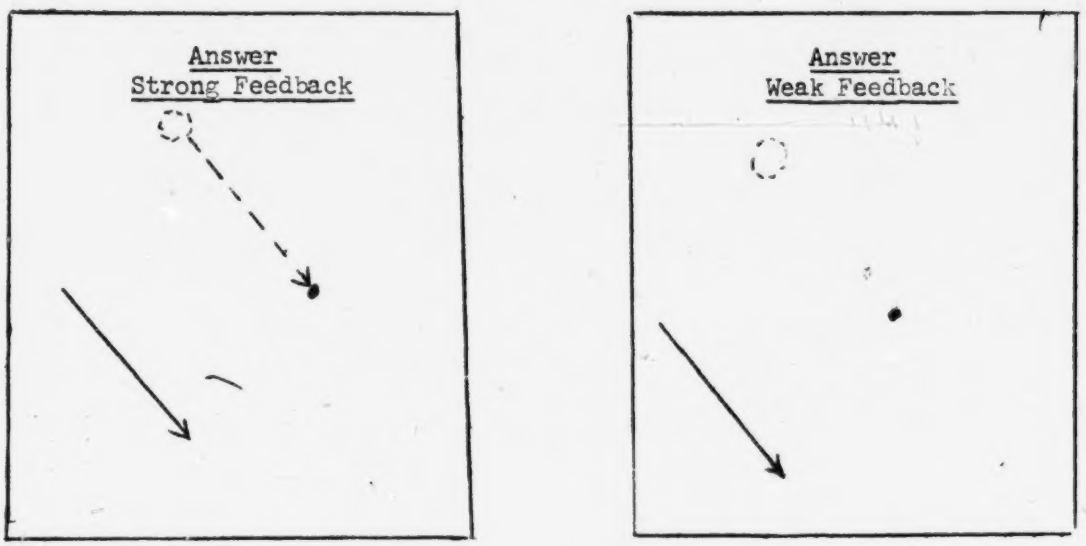


Figure 2



or audio).

After a group of Ss had been processed, the learning sequence was revised on the basis of the results, by dropping some stages and adding others. As a result, the number of stages was reduced in number and changed qualitatively in slight ways as the research progressed. (The same treatments were involved throughout however.) This process represents a synthesis of experimental design, on the one hand, and experimental analysis on the other, both with the objective of improving teaching/learning systems in the schools.

While this procedure went on, there was also a search for an inexpensive graphic capability, i.e. touch-sensitive and interactive. Some outcomes of this search are reported in the Appendices.

Subjects: Subjects were fourth, fifth, and sixth graders in local elementary schools. Some were in "project centered" classrooms, others in "traditional" classrooms. In some cases, the subjects worked on the materials via a computer terminal installed in the classrooms: in other cases they were driven to the University Some subjects were participants in a special summer school in a neighboring town: the terminal was installed in a vacant room in that school.

Results: (a) Learning data were recorded for each subject for each stage under each treatment. They generally supported an all-or-nothing view of the learning process. (Excerpts are given in the Appendices.)

(b) In the learning process and on the immediate post-test there were no statistically significant differences between the two levels of variation: what differences there were generally favored the treatment where only two different tasks were given and were repeated five times each.

(c) In the learning process and on the immediate post-test there were no

statistically significant differences favoring strong feedback over weak feedback, but the strong feedback seemed to make initial learning easier. Once the Ss became accustomed to receiving no verbal guidance during the task, they began to look to the feedback (the correct answer) for guidance.

(d) The delayed post-test was given in November of the next school year. This was five months after the last S had completed the learning program and post-test, except for the summer school students for whom it was about four months. The data from the delayed post-test, Table 1, suggest an interaction. Only one of the differences shows significance via t-test, that being W2/S2 (i.e. weak feedback vs. strong at the two-different-example level). S5/S2 (i.e. strong feedback at five and two different examples) approaches statistical significance at the .05 level. Since both strength of feedback and amount of variation of examples are forms of redundancy, the implication is that there is an optimal redundancy level which can be approached in more than one way. Whether W5 is really "over the hump," i.e. represents too little total redundancy for effective learning, is a matter of conjecture.

Conclusions: These results suggest that strength of feedback and amount of variation are educationally significant in the design of inductive instructional sequences. Since both are types of guidance, this replicates previous investigations regarding guidance and discovery. These results also suggest, although weakly, that there is an interaction between the two forms of redundancy, and that simultaneous reduction of both types (increased variation, weaker feedback) places too great a load on the learner - thus reversing the delayed-post-test advantage of each one individually.

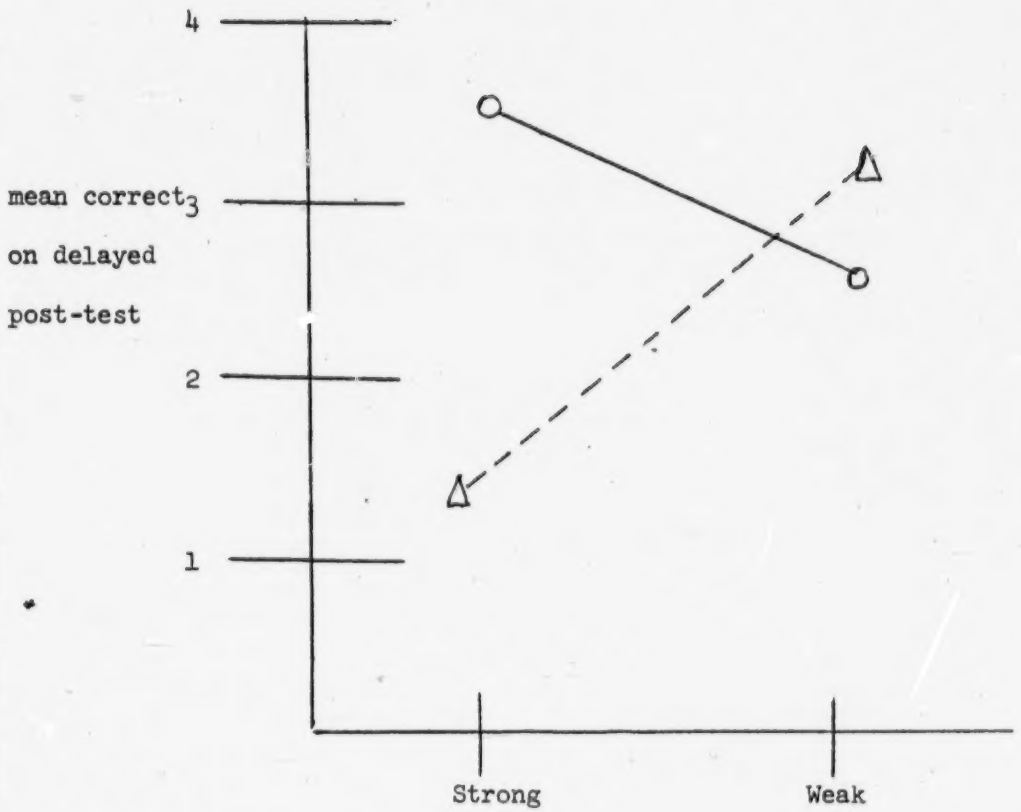
Secondary outcomes of this study include support for the efficacy of non-wordal instructional processes (i.e. without words, or "non-verbal"), and

TABLE 1

Results, Delayed Post-Test

	Two different examples five times each	Five different examples two times each
Strong Feedback	$\bar{X}$ = 1.65 6 = 1.32 N = 16 S2	$\bar{X}$ = 3.35 6 = 2.35 N = 10 S5
Weak Feedback	W2 $\bar{X}$ = 3.14 6 = 1.82 N = 14	W5 $\bar{X}$ = 2.80 6 = 2.18 N = 17

TABLE 2



○ Five different examples.
△ Two different examples.

demonstrate a need for a graphic computer display which interprets spatially-oriented responses, as a vehicle for teaching and learning concepts and processes which can be modelled iconically.

One subjective conclusion on the part of the research assistant was that the weak-feedback group took longer to respond. However, the learning data do not indicate that they made more errors, or took longer to come to the correct answer.

Another subjective conclusion on the part of the research assistant was that the students learned how to learn, i.e. they became much more at ease with and effective at the strategy of using the answer to one task to give them clues as to the answer to the next. Thus they learned to be more aware of feedback and to be quicker to utilize it. Replications should explore this possibility.

Discussion: This experiment indicates that immediate results do not necessarily indicate the power of an instructional process, and suggests that a given instructional problem may have an optimal solution, given parameters related to mode, learning strategy, and such. Its major significance, however, lies in the attention to variables which, while eminently practical, have not been investigated experimentally to a degree commensurate with their importance. The amount of variety given a student in his homework, for example, evidently has some bearing on his understanding in terms of transfer and retention over a period of time: the same goes for the type of feedback. Whether the delayed effect found here is important in everyday school learning, where material learned may be processed a number of times in the course of subsequent lessons, is not at all clear. Also, the effects of varying the number of tasks at each stage are not clear. Thus, additional investigation is called for in

relation to two questions: (a) does the absolute number of tasks given have a significant effect on learning, transfer, and retention; (b) do repetition and feedback effects have significance in situations where the concepts and processes are used immediately and regularly after the initial learning, as in many aspects of mathematics?

BIBLIOGRAPHY

(1) Bourne, Lyle E., Jr. Human Conceptual Behavior, Boston, Allyn and Bacon, 1966.

(2) Bourne, L. and Haygood, R. "The role of stimulus redundancy in the identification of concepts," Journal of Experimental Psychology, 1959, 50, 232-238.

(3) Brocht, Glenn H. and Glass, Gene V. "The External Validity of Experiments," American Educational Research Journal, Vol.V No. 4, Nov. 1968, Pp. 437-474.

(4) Dwyer, Francis M., Jr. "Adapting visual illustrations for effective learning," Harvard Educational Review, 37, 250-263; Spring 1967.

(5) Gagne, R., Mayor, J., Garstens, H.L. and Paradise, N.E. "Factors in acquiring knowledge of a mathematical task," Psychological Monographs, 1962, 76, No. 7, Whole No. 526.

(6) Grant, D.A. and Berg, E.A. "A behavioral analysis of degree of reinforcement and ease of shifting to new responses in a Weigl-type card sorting problem" Journal of Experimental Psychology, 1948, 38, 404-411.

(7) Haselrud, George M. "Relationship between the way general and specific principles are learned and how they are used," Final report, Project No. 3108, U.S. Department of Health, Education, and Welfare, Office of Education, Bureau of Research.

(8) Huttenlocker, Janellen. "Effects of manipulation of attributes on efficiency of concept formation." Psychological Reports, 1962, 10, 503-509.

(9) Kendler, H.H. and Vineberg, R. "The acquisition of compound concepts as a function of previous training," Journal of Experimental Psychology, 1954, 48, 252-258.

(10) Morrisett, L. and Hovland, C. I. "A comparison of three varieties of training in human problem solving," Journal of Experimental Psychology, 1959, 58, 52-55.

(11) Meisser, U. and Weene, P. "Hierarchies in concept attainment," Journal of Experimental Psychology, 1962, 64, 644-645.

(12) Smith, M.Daniel and Bolyard, A. Joyce. "Interaction of words and non-wordal stimuli in programed sequences of concept-formation tasks," AV Communication Review, 14, 4, Winter 1966, 514-531.

(13) Travers, R.M.W. and Oevering, R.L.R. "Variations in the amount of irrelevant cues in training and testing conditions and the effect on transfer," Journal of Educational Psychology, 58: 62-68; Feb. 1967.

Bibliography (cont'd)

(14) Wallace, J. "Concept dominance, type of feedback and intensity of feedback as related to concept attainment," Journal of Educational Psychology, 1964, 55, 159-166.

(15) Anderson, Richard C. "Control of Student Mediating Processes During Verbal Learning and Instruction," Review of Educational Research, Vol. 40 No. 3, June 1970, Pp. 349-369.

(16) Nuthall, Graham. "An Experimental Comparison of Alternative Strategies for Teaching Concepts," American Educational Research Journal, Vol. 5, No. 4, November 1968, Pp. 561-584.

APPENDIX A

CHRONOLOGICAL REPORT OF PROCEDURES AND RESULTS

LEARNING DIFFICULTY IN MATHEMATICS RESEARCH

The purpose of the Learning Difficulty in Mathematics Research is to teach an algebraic concept (that of vectors) to children at the elementary school level. This concept will be for use on a computer so that the child will be able to learn the concept without the assistance of an instructor. This will be beneficial in that 1) a child can work by himself and go ahead at his own pace 2) children interested in this field or children who have a better than average intelligence will not become bored because they can advance in the field of mathematics farther than they normally would be able to, although the program is for almost everyone (explained later), these students are the ones usually held back by the system, 3) working without the teacher allows the child to work without the very common bias against mathematics that appears in many elementary school teachers and can be related to the children so that they too will have a dislike of mathematics.

The students being used in this research are from the Oyster River Elementary School in Durham, New Hampshire. At this time, the three classes of the fourth, fifth, and sixth grades that are considered Project Centered Classes are being used. Eventually the other fourth, fifth, and sixth grades at the Oyster River School will be utilized also. Four college students were put through the first three groups plus group 99 to give practice to the Research Assistant doing the experiments. All four college students did well in group 99 (all groups will be explained later) but could not do groups 1, 2, or 3. Because only four college students were used nothing has essentially been proven but it might be postulated that college students perhaps already have too much knowledge to do these simple tasks. Because of their knowledge they complicate the task and try to find "more in it than is there." It might be interesting to later follow up this line of thought and to test the postulate.

Sixty-two students have been put through the first two parts of the program (gone through group 7).

25 of the students are fourth graders

20 of the students are fifth graders

17 of the students are sixth graders.

All of the students understand the concepts given to them up to this point and the findings on their results will be reported later. If the students could not understand the concept, it was taught to them by the Research Assistant.

There were few extreme learning problems. Only those students who wanted to participate in the program did. One fifth grade girl, who has gone through group 7, still does not understand the concepts that were taught. She considered it cheating to be told how to do the work and would not cooperate even when the Research Assistant told her that other children needed to have it explained to them also. It is questionable as to whether the girl will continue with the program or not. A fifth grade boy broke down and cried when he could not get the answers even though it was explained to him that no one at that time was doing very well, that the program was not a test and if he got answers wrong it was the fault of the program because it had not yet been perfected. He was also told that even college students had done poorly in the program. The boy remained upset and continued to say that it was "unfair." This boy did fine the second time that he was seen, but this time his success rate in the program greatly improved also. Some students giggled (nervous? or just having fun?), others took the program very seriously and would stare and study the problems and answers diligently, and others were very carefree about their work and would just as soon have the Research Assistant tell them how to do the problems. One problem that occurred frequently had to do more with the children's learning style than the program. To begin the

program the Research Assistant sits beside the student and turns the pages of problems and answers, explains the use of the computer, and how the program works. The students feel that the Research Assistant sits beside the student and turns the pages of problems and answers, explains the use of the computer, and how the program works. The students feel that the Research Assistant is there to help them when they "get stuck" and the Research Assistant has to constantly tell the student that she cannot tell them anything other than their basic instruction and that they must "figure out" how to do the problems by looking at the answers and using that to do the next problem. Students are accustomed to asking how to do something and getting an answer from a teacher instead of figuring it out for themselves. This would appear to be the explanation of the problem. Eventually when the Research Assistant does not have to stay with the student all the time, the student will not look to someone else as a crutch. The students can and will have to be able to do the program without the help of an adult (except perhaps in the basic explanation) or the program is not good. Because the student can continue and do the problems by himself (after being reminded by the Research Assistant that this is the way he must do the work) even at this point in the program, it is conceivable that he will have no problems later on doing the program when a Research Assistant is not available.

Work at Morrill Hall: About 50 students were worked with for the first time with the terminal in the Education Department in Morrill Hall. The Research Assistant would pick up the children (with a University car) at the school and return them. (9:00 - 10:30 AM and 1:00 - 2:30 PM) This was usually the time schedule that was kept. Monday, Wednesday and Friday mornings and Monday and Friday afternoons were the usual days. The Research Assistant averaged three students during each of these sessions. Permission slips were brought home and signed by the parents of the children wishing to

participate in the program. The children who came to the University for the program were treated to an ice cream cone after they finished the program as a "reinforcer." Because only one student could participate in the program at a time, the other two students were told they could roam the building, write on the blackboards in vacant classrooms, but please do not bother anyone or be exceptionally noisy. There were never any problems with any of the students. They loved meeting ERIC (Educational Research Information Center), the title given to the terminal. The idea of a terminal having a name was refreshing to them. The use of the terminal was no problem to any of the students. They have a basic description of the terminal, why the phone is hooked up to it (connecting the terminal with the main computer in Kingsbury Hall), and what keys they will have to use. When the terminal says "READY?," the student has to answer by pushing the "Y" that stands for YES. Several of the students figured out that they could press the "N" (for NO) and the terminal will ask again if the student is ready. Also many students figured out that if they press another letter other than either "Y" or "N" the terminal will tell them that they have made an error and must repeat that line. Other students figured out that if they wrote anything else after the "Y" or "N" the computer would still accept their answer and disregard everything else so they enjoyed themselves by writing trivia and having it come out on their papers. Most of the students also realized that after they pointed to an answer on their problem that by the Research Assistants pressing either #1, #2, or #3 was the reason that they were getting their answers. They determined quite rapidly that #1 referred to the answer "RIGHT ON!", #2 referred to the answer "QUITE CLOSE" and #3 referred to the answer "TOO FAR OUT". Those who did not figure this out were usually told by others who had deduced this information. All except perhaps two students were excited about being able to keep the paper (with their answers on it) that

came out of the terminal. Even if many of their answers were "TOO FAR OUT", this did not seem to make any difference. Working with the students at Morrill Hall was very effective but very slow in that transportation took up much time. Also the children were being taken away from their classrooms for half a day (which, of course, the students did not mind).

Oyster River Elementary School: The program moved into the Oyster River Elementary School when a Portable Terminal was borrowed from Academic Computing on campus. Three telephone jacks were installed in the three classrooms to be used for the program. The telephone used is only a University phone (red line) and remains in the office when not in use. A University car is still used to transport the terminal from the Academic Computing Office to the Oyster River School and approximately the same times were kept as before. There was no problem in setting up the terminal in the classrooms after the initial newness of the terminal wore off. In each class, there is a specific area to be used for the terminal and after moving a few desks and chairs it is set up quite easily. The students had to be told several times that only one person at a time was to be in the terminal area and if they had not done the program they could not watch the others do it. It was much more efficient to administer the program to the children right in their classrooms. The students were only taken away from their studies for approximately 15 to 20 minutes. Tootsie Roll Pops were given to each student after he worked on the program as the "reinforcer". There were a few comments about not getting ice cream cones but it was explained to them that only the students who volunteered to go to the University received them and that, of course, it was impossible for the Research Assistant to bring ice cream cones to the school; therefore, the lollypops were being used. This was accepted by the students. After several weeks of work at the Oyster River School, the Academic Computing Office stated that the program would have

to get its own terminal because their terminal could not be utilized as much by one user. For several days, the research continued with the use of a t.v. terminal that was lent to Academic Computing and could be used by the Learning Difficulties in Mathematics Research in the morning. This terminal is much lighter than the portable terminal previously being used. It was hooked into the schools's television and worked very well. The students were excited about the use of a different type of terminal but were disappointed that they would not have paper (with their answers) to keep and that everyone could see if they got their answers right or not. This terminal was used the week prior to the student's weeks vacation (Feb. 21-25) and was not available after their vacation.

The terminals used at present are the 360 terminal at the Education Department, a protable terminal (portoCom), and a television terminal. At this time in the research, it is not absolutely necessary to use a computer. By utilizing the computer the program 1) is getting the students used to using a machine while they work 2) experimenting with the type of problems it will be necessary for the computer to contend with, and 3) the computer is also a great reinforcer for the children. The students love working with a machine and are fascinated by the work it can do. They are constantly asking questions like: Where does the telephone go to? Can you call anywhere on the Phone? Can the computer tell me how old I am? How does the computer always know the correct time?, and How is ERIC feeling? They enjoy personifying the computer terminal and actually treat it more like a friend than a machine.

EXPLANATION OF GROUPS

The program is made up of groups that are units of tasks similar in nature.. For the most part each group contains ten tasks although this is not a set number. The groups are developed as the program progresses and the students become ready to advance.. At the present time there are twenty groups and explanation and discription of each will follow. It must be remembered that the number of the group does not necessarily mean anything but is used as a name or title for the group..

Group 99: This group is a prerequisite for the program; in that if a student cannot do any of the work in this group,, than he is not perceptually capable of doing the rest of the program which does take a certain amount of learning maturity to complete..

Tasks 1-3 have the following directions: Which two of these lines has something in common:

(a) (b) (c)

answer: (b) and (c)

reason: equality of length

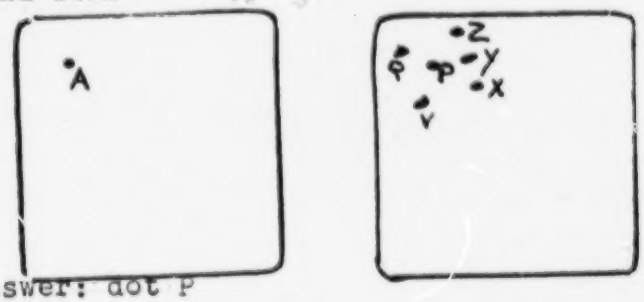
Tasks 4-6 have the same directions as the above tasks..

(a) (b) (c)

answer: (a) and (c)

reason: directions are the same.

Tasks 7-9 have the following directions: Which dot in the right hand box is in the same relative position as the dot in the left hand box.

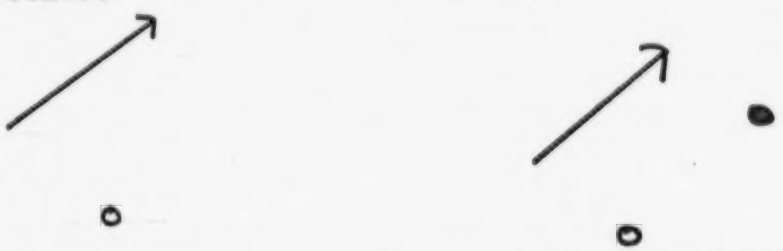


answer: dot P

Groups 1 and 2: These two groups utilize the same tasks. The task is to point to a place on the page that would construct a vector equal in length and direction as the vector already on the page starting with the open dot (O) that is also already on the page.

Example:

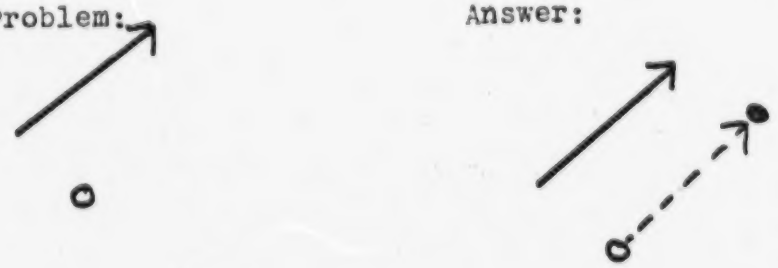
Problem: Answer:



There is also a Group 1a and Group 2a.. These groups consist of the same task but have a strong feedback represented by dotted vectors..

Example:

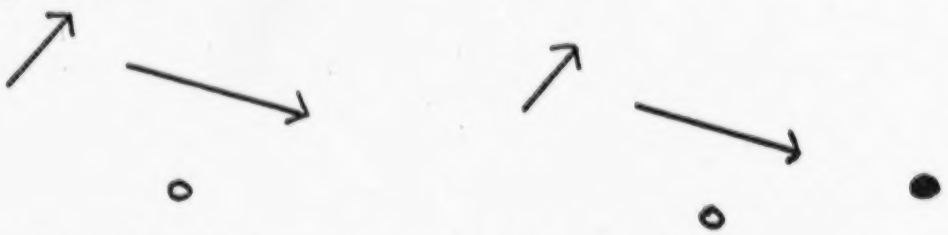
Problem: Answer:



Group 3: The task of the group is to add two vectors already on the page starting with the open dot and arrive at a correct point equal to the sum of (and in the same direction as) the two vectors already mentioned.

Example:

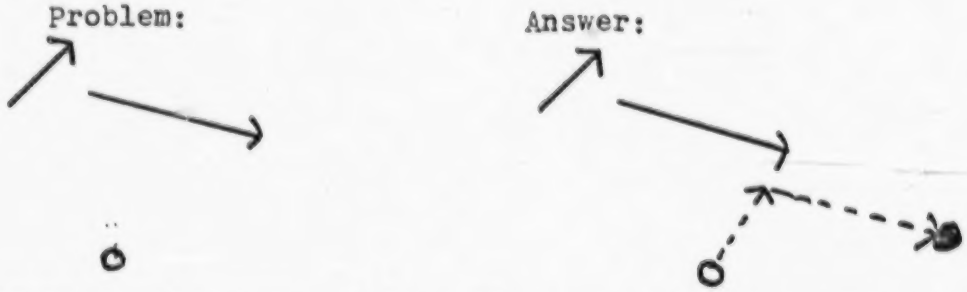
Problem: Answer:



Group 3a: This group has the same tasks as group 3 but with strong feedback

Example:

Problem: Answer:

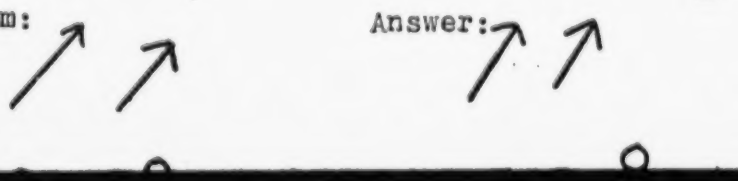


Group 4: This group is the same a s Group 3 except it only contains 4 tasks.. This group was used to determine whether the students retained the knowledge of the task of Group 3 after a short interium of a few weeks..

Group 5 and Group 6: Both of these groups utilize the same tasks. The task is to add two vectors that are in the same direction starting at the open dot and the answer is a point equal to the length of the two vectors and in the same direction.

Example:

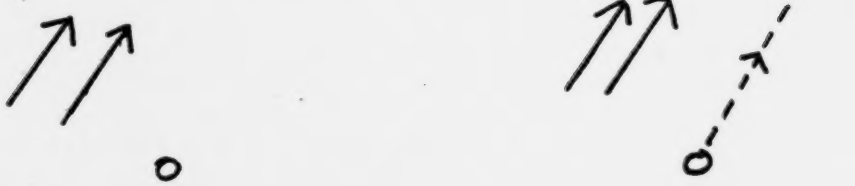
Problem: Answer:



Group 5a and Group 6a: These groups have the same tasks as groups 5 and 6 except with strong feedback.

Example:

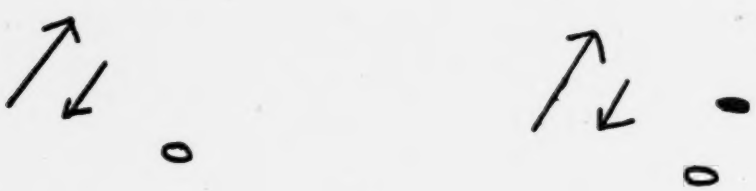
Problem: Answer:



Group 7, Group 8, and Group 9: These three groups utilize the same task. Shown as the problem are two vectors of various lengths but going in opposite directions and an open dot to be used as a starting point. The student must point to a place that is found by adding the 2 vectors and using their direction.

Example:

Problem: Answer:



Group 7a, Group 8a, Group 9a: These three groups have the same tasks as the above groups except a strong feedback is used.

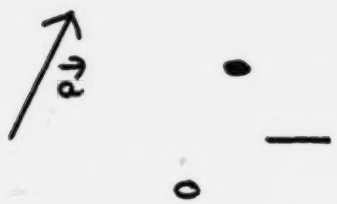
Example:

Problem: Answer:

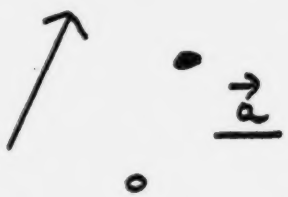
Group 10: The task of this group is shown in the problem as a labeled vector with the open dot and closed dot representing a vector of the same length and direction as the labeled vector. The student must label this second vector the same as the first.

Example:

Problem:



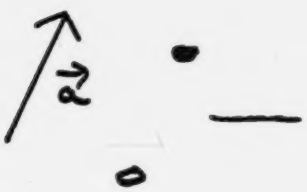
Answer:



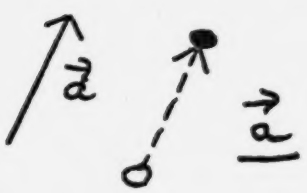
Group 10a: This group has the same task as the above group only it has strong feedback.

Example:

Problem:



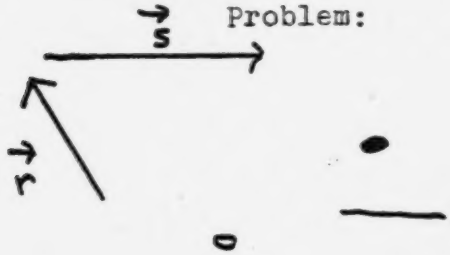
Answer:



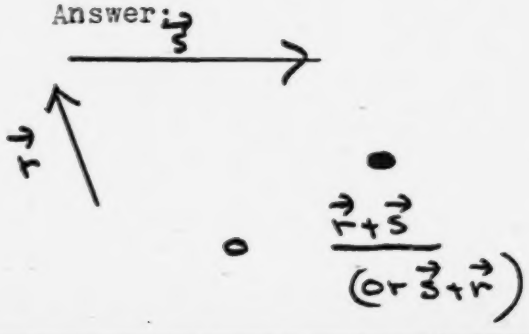
Group 11: The task for this group is for the student to determine what label should be given for the distance depicted by the open and closed dots shown in the problem. The student must state that the two vectors shown on thepage are added to determine the answer.

Example:

Problem:

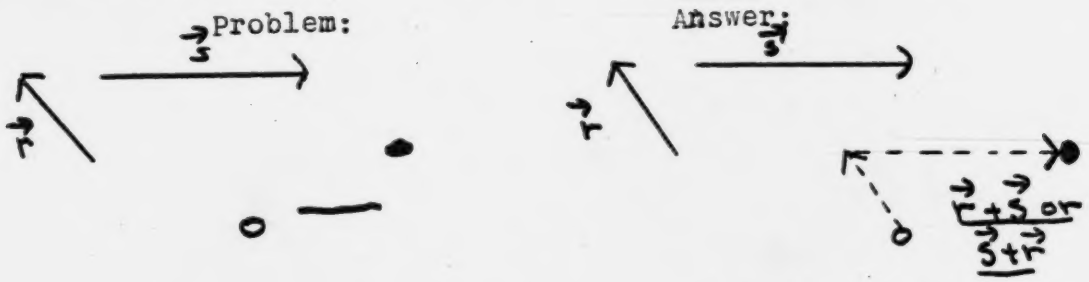


Answer:



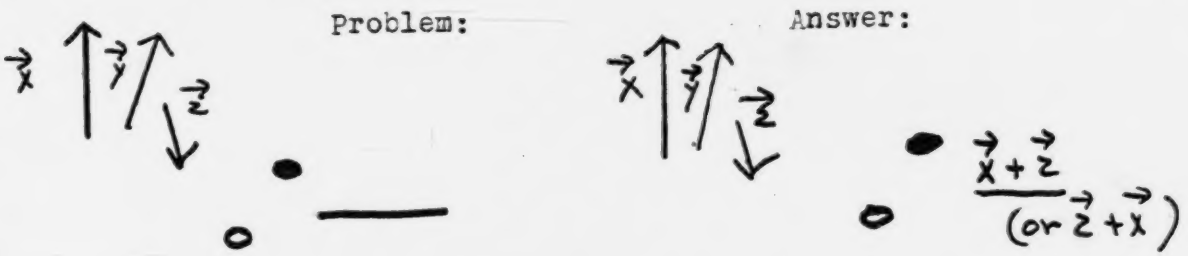
Group 11a: This group consists of strong feedback for the task shown in Group 11.

Example:



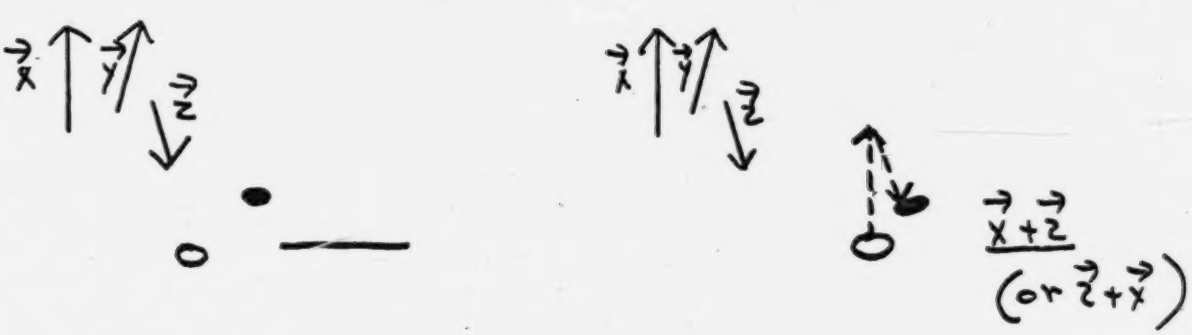
Group 12: The task for this group is for the student to choose among three vectors on the page and determine which two, when added, depict the distance shown by the open and closed dots.

Example:



Group 12a: This group consists of strong feedback for the task shown in Group 12.

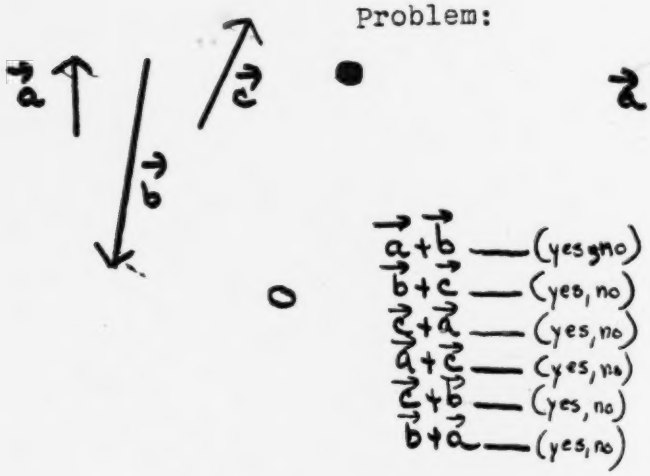
Example:



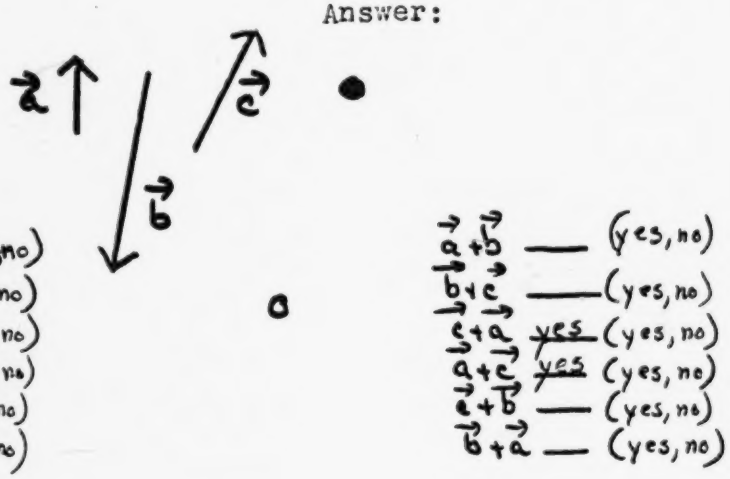
Group 13: The task of this group is a multiple choice answer shown by the problem of having three labeled vectors, an open dot and a closed dot on the page. The task is to determine which two vectors when added together give the answer represented by the open and closed dots. The student must choose two answers.

Example:

Problem:



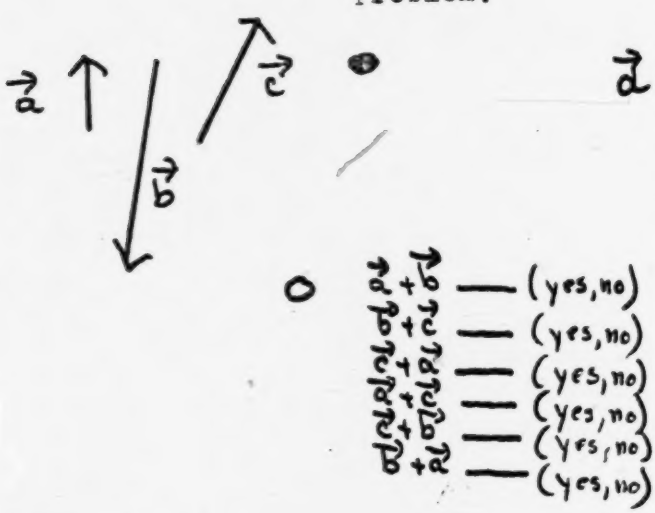
Answer:



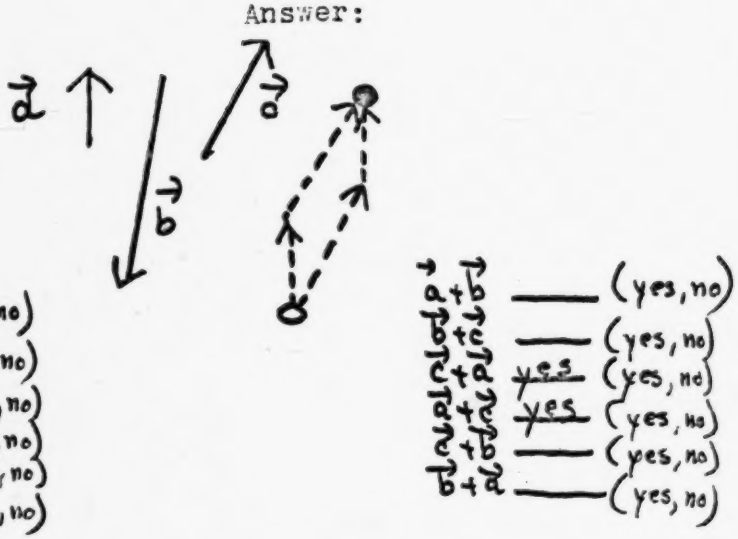
Group 13a: This is actually part of Group 13. The last five tasks in Group 13 have strong feedback.

Example:

Problem:

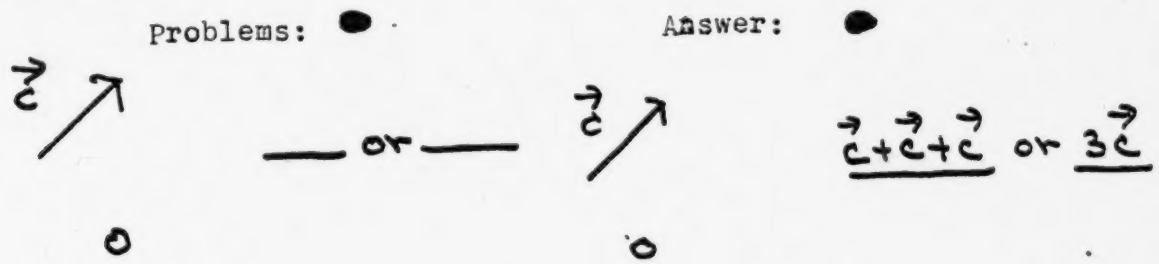


Answer:



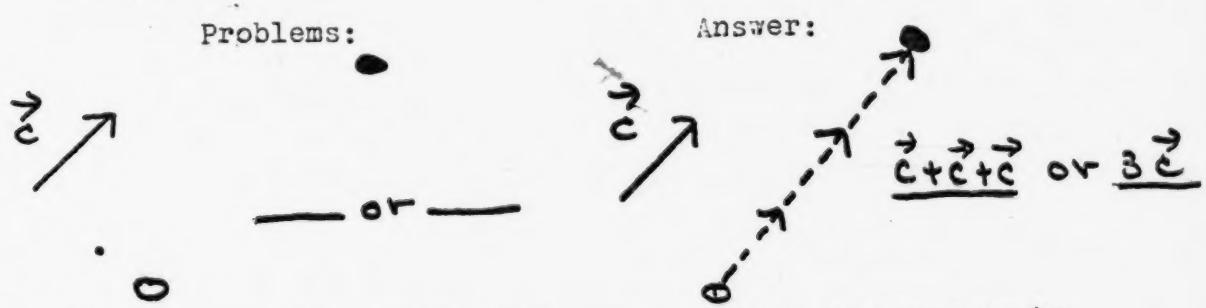
Group 14 and Group 15: These two groups utilize the same tasks. There is one labeled vector represented in the problem, an open dot, and a closed dot. The student must determine how many of the labeled vectors does it take to make the distance represented by the open and closed dots.

Example:



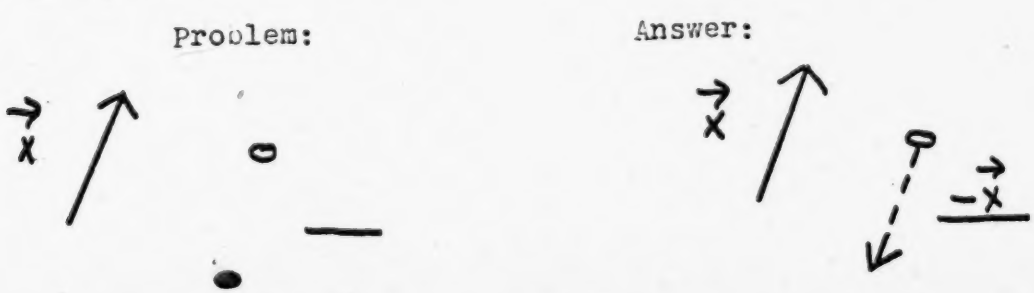
Group 14a and Group 15a: These groups consists of the same tasks as above but have strong feedback.

Example:



Group 16 and Group 17: These two groups utilize the same tasks. A labeled vector and an open and closed dot are shown on each page. The student must name the new vector represented by the open and closed dot.

Example:

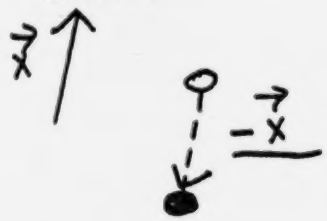


Group 16a and Group 17a: These groups consist of the same task as Group 16 and Group 17 but have strong feedback.

Example:

Problem:

Answer:

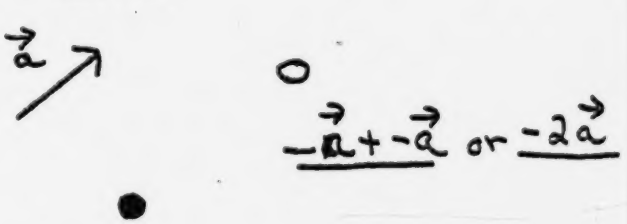


Group 18 and Group 19: These two groups utiliz e the same task. A labeled vector and an open and closed dot are shown on each page. The student must determine the number of vectors needed to fill the space represented by the open and closed dots. All of the spaces are in a negative direction.

Example:

Problem:

Answer:

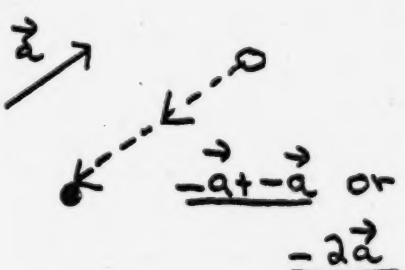


Group 18a and Group 19a: These groups consist of the same task as Group 18 and Group 19 but have strong feedback.

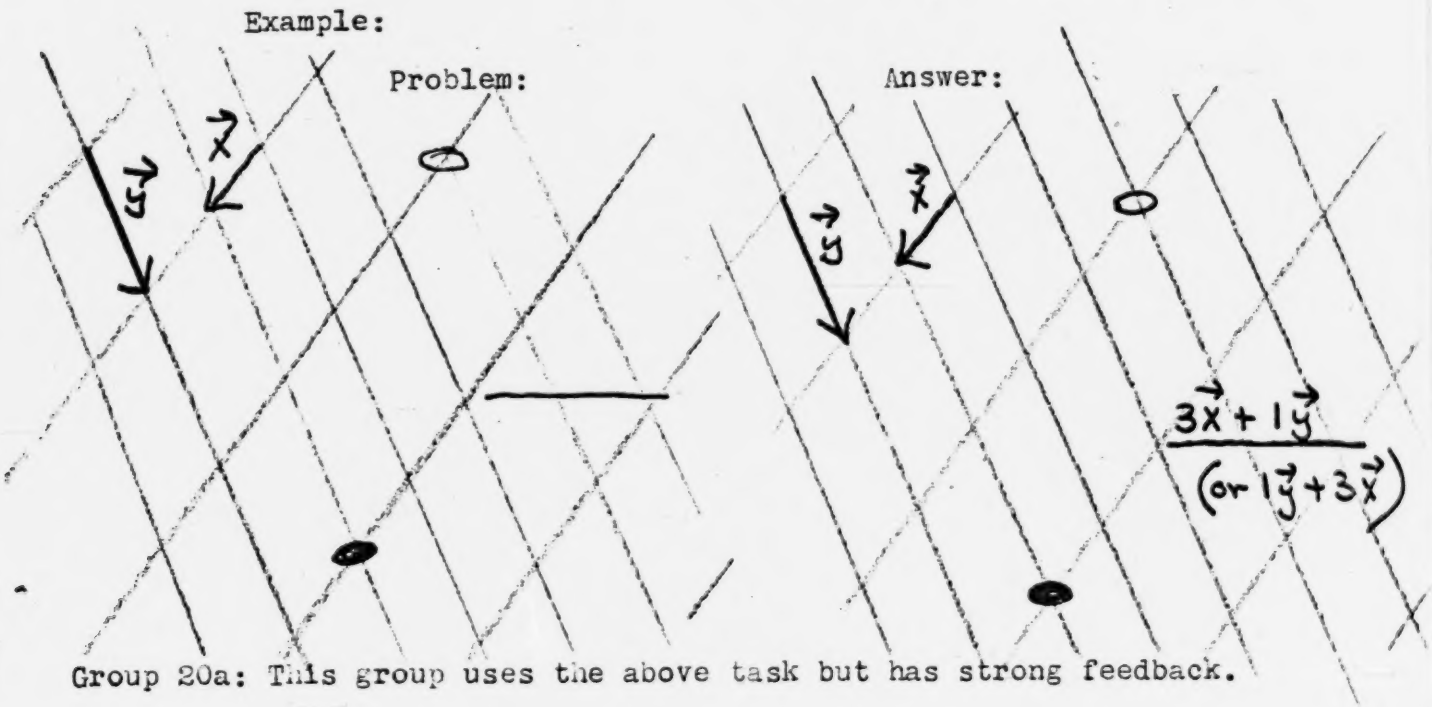
Example:

Problem:

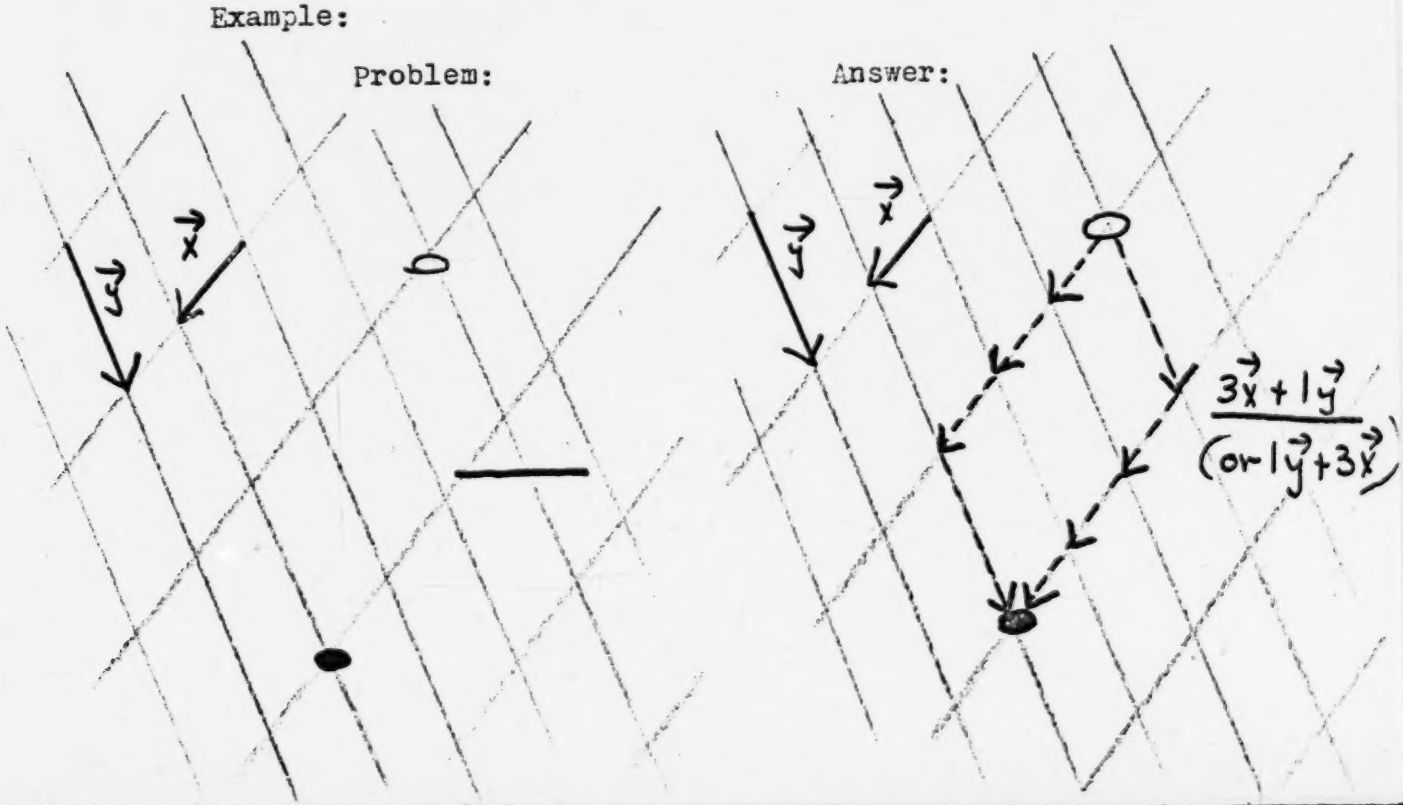
Answer:



Group 20: This group's task utilizes a grid that is made by using the direction and distance of the two labeled vectors given on the page. The student must label the space represented by the open and closed dots.



Group 20a: This group uses the above task but has strong feedback.

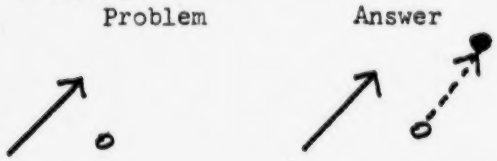


GROUPS ABBREVIATED

. This page shows the tasks (by example with strong feedback) of the groups. If a group is not understood clearly go back and look at the complete explanation on pages 8 - 17.

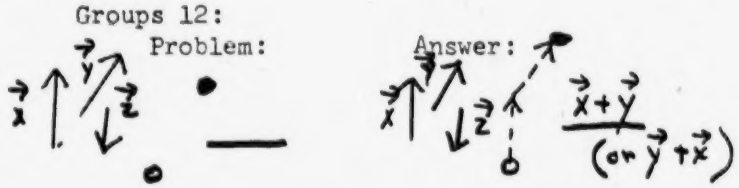
GROUPS 1 and 2:

Problem Answer



Groups 12:

Problem: Answer:

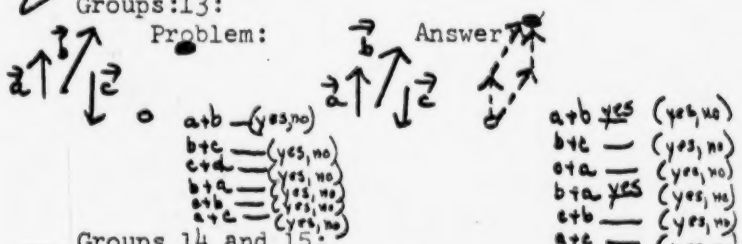


GROUPS 3 and 4:

Problem: Answer:

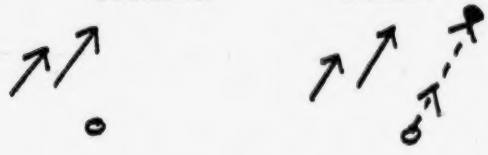
Groups:13:

Problem: Answer:



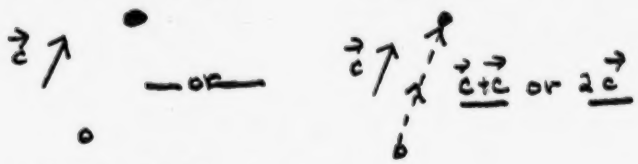
Groups 5 and 6:

Problem: Answer:



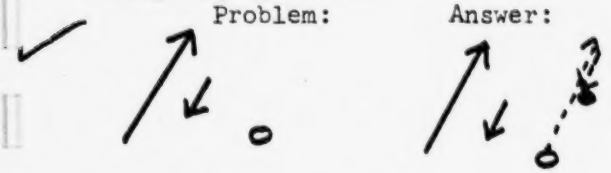
Groups 14 and 15:

Problems: Answer:



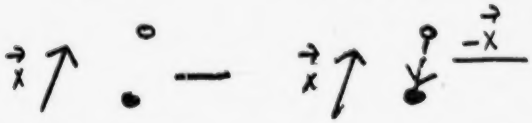
Groups 7, 8, and 9:

Problem: Answer:



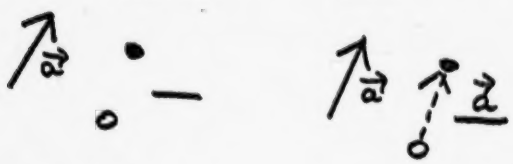
Groups 16 ans 17:

Problem: Answer:



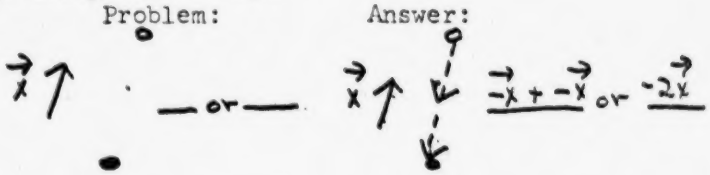
Group 10:

Problem: Answer:



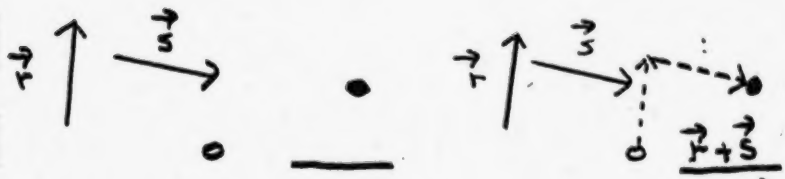
Groups 18 and 19:

Problem: Answer:



Group 11:

Problem: Answer:



Group 20:

Problem: Answer:

EXPLANATION OF TERMINAL

** NOTE NEXT FEW PAGES TAKEN FROM THE CALL#360 COMPUTER TERMINAL
(numbers on this page correspond to numbers on next few pages)

(1) The terminal is signed on and once the User Number and Password have been given, it is ready to start with the program. (2) The Research Assistant UNLOCKS GROUP,, this is to be sure that the information will stay within the computer and can be run back qt another time when needed. (3) RUN DATCOL is the title of the program and Run allows the program to be used.. (4) RA stands for research assistant, STD, stands for student number, and GRP stands for Group number. This is used for filing purposes, to keep track of the work being done. (5) The students directions are given next. These are the only directions the student is given except an explanation of the terminal and what the program is which is given prior to this.. (6) The terminal next prints the question READY?.. (7) The student answers YES (Y is a sufficient answer). (8) The terminal prints the question ANSWER. (9) The Research Assistant answers by pressing 1, 2, or 3 depending on the students response to the problem that is presented on paper by the Research Assistant. (10) The terminal then prints RIGHT ON!, QUITE CLOSE, or TOO FAR OUT depending on the prior response given by the Research Assistant of either 1, 2, or 3. (11) When the group is finished the terminal prints the question FINISHED? (12) The student must then answer YES or NO (again the first letter of either word is sufficient). (13) If the answer is NO to the above question the terminal prints the information necessary to begin a new group. (14) When this group is finished the terminal will again print the question FINISHED?

(15) If the answer by the student is YES (16) the terminal will print the Computer Time and wait for further instructions. (17) The Research Assistant prints LOCK GROUP on the terminal, this insures that the information put into the computer will not be lost. (18) The Research Assistant prints OFF on the terminal and (19) the terminal will terminate.

(20) This page shows a listing of all information that has thus far been used by the program (under file TWO only). This enables the researchers to go back and review what has taken place. There will not be an explanation of this, as the findings are reported in the pages that follow.

Sample Computer Response Sheet
From One Session With a Student

```
9/ON AT 13:09   WED. FEB. 23 1972 LINE 5
CALL-OS SYSTEM UP UNTIL 06:00. BXX111 IS NOW INVALID.
1. USER NUMBER,PASSWORD--LXX182,
READY

2. UNLOCK GROUP
READY

3. RUN DATCOL

DATCOL      13:09   WED. FEB. 23 1972


FILENAME:
?TWO

FILE=TWO      NREC= 21
4. RA,STD,GRP:
?1,1,99

EACH PICTURE IS A PROBLEM. PLEASE POINT TO A PLACE
ON THE PAGE WHICH IN YOUR OPINION IS THE CORRECT
5. ANSWER. THE COMPUTER WILL TELL YOU WHETHER YOU WERE
RIGHT ON THE CORRECT PLACE, CLOSE TO IT, OR TOO FAR OFF.

6.   1  READY?
7. ?Y
8. ANSWER?
9. ?3
10.    TOO FAR OUT

     2  READY?
   ?Y
   ANSWER?
   ?2
      QUITE CLOSE

     3  READY?
   ?Y
   ANSWER?
   ?1
      RIGHT ON!

     4  READY?
   ?YES
   ANSWER?
   ?1
      RIGHT ON!

     5  READY?
   ?YES I AM READY
   ANSWER?
   ?2
      QUITE CLOSE
```

```
  6  READY?
?Y
ANSWER?
?3
   TOO FAR OUT

  7  READY?
?Y
ANSWER?
?1
   RIGHT ON!

  8  READY?
?Y
ANSWER?
?1
   RIGHT ON!

  9  READY?
?Y
ANSWER?
?1
   RIGHT ON!

11. FINISHED?
12. ?N

    FILE=TWO       NREC= 22
13. RA,STD,GRP:
    ?1,1,3


 20  READY?
?Y
ANSWER?
?1
   RIGHT ON!

 21  READY?
?Y
ANSWER?
?2
   QUITE CLOSE

 22  READY?
?Y
ANSWER?
?3
   TOO FAR OUT

 23  READY?
?Y
ANSWER?
?1
   RIGHT ON!
```

```
 24  READY?
?Y
ANSWER?
?3
   TOO FAR OUT

 25  READY?
?Y
ANSWER?
?1
   RIGHT ON!

 26  READY?
?Y
ANSWER?
?1
   RIGHT ON!

 27  READY?
?Y
ANSWER?
?1
   RIGHT ON!

 28  READY?
?Y
ANSWER?
?1
   RIGHT ON!

 29  READY?
?Y
ANSWER?
?1
   RIGHT ON!

14. FINISHED?
15. ?Y
16. TIME 10 SECS.
17. LOCK GROUP
    READY
18. OFF
    OFF AT 13:15
19. PROC. TIME...   10 SEC.
    TERM. TIME...   6 MIN.
```

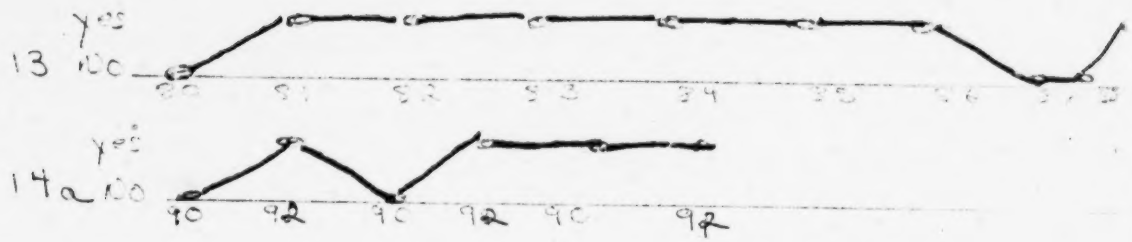
```
READY

UNLOCK GROUP
READY

RUN LIST

LIST          13:16   WED. FEB. 23 1972


FILENAME:
?TWO

TWO          22       686
31  1  1  63  99  1  2  1  3  4  1  5  6  1  7  8  1  9  10  1  11  12
1  13  14  1  15  16  1  17  18  2
34  2  1  63  3  19  20  3  21  22  3  23  24  1  25  26  1  27  28  1
29  30  1  31  32  1  33  34  1  35  36  1  37  38  1
34  3  1  63  7  39  40  2  41  42  1  43  44  1  45  46  1  47  48  1
49  50  1  51  52  1  53  54  1  55  56  1  57  58  1
34  4  1  56  7  1  2  1  3  4  1  5  6  1  7  8  1  9  10  1  11  12  1
13  14  1  15  16  1  17  18  1  19  20  1
31  5  1  64  99  1  2  1  3  4  2  5  6  1  7  8  1  9  10  1  11  12
1  13  14  1  15  16  1  17  18  1
34  6  1  64  3  19  20  3  21  22  3  23  24  2  25  26  1  27  28  1
29  30  1  31  32  1  33  34  1  35  36  1  37  38  1
34  7  1  64  7  39  40  1  41  42  1  43  44  1  45  46  1  47  48  1
49  50  1  51  52  1  53  54  1  55  56  1  57  58  1
16  8  1  27  4  1  2  1  3  4  1  5  6  1  7  8  1
34  9  1  27  7  9  10  1  11  12  1  13  14  1  15  17  1  18  19  1

20  21  1  22  23  1  24  25  1  26  27  1  28  29  1
16  10  1  57  4  1  2  1  3  4  1  5  6  1  7  8  1
34  11  1  57  7  9  10  3  11  12  2  13  14  1  15  16  1  17  18  1
19  20  1  21  22  1  23  24  1  25  25  1  29  30  1
34  12  1  65  3  1  2  3  3  4  3  5  6  3  7  8  2  9  10  1  11  12
1  13  14  1  15  16  1  17  18  1  19  20  1
34  13  1  65  7  21  22  1  23  24  1  25  26  1  27  28  1  29  30  1

31  32  1  33  34  1  35  36  1  37  38  1  39  40  1
16  14  1  42  4  1  2  3  3  4  1  5  6  1  7  8  1
34  15  1  42  7  9  10  1  11  12  1  13  14  1  15  16  1  17  18  1
19  20  1  21  22  1  23  24  1  25  26  1  27  28  1
16  16  1  59  4  1  2  1  3  4  1  5  6  1  7  8  1
34  17  1  59  7  9  10  1  11  12  1  13  14  1  15  16  1  17  18  1
19  20  1  21  22  1  23  24  1  25  26  1  27  28  1
34  18  1  65  13  1  2  3  3  4  1  5  6  1  8  9  1  10  11  1  12  13

1  14  15  2  16  17  1  18  19  1  21  22  2
31  19  1  1  99  1  2  3  3  4  2  5  6  1  7  8  2  9  10  1  11  12
3  13  14  1  15  16  1  17  18  3
34  20  1  1  1  19  20  1  21  22  2  23  24  2  25  26  1  27  28  2
29  30  1  31  32  2  33  34  1  35  36  1  37  38  1
31  21  1  1  99  1  2  3  3  4  2  5  6  1  7  8  1  9  10  2  11  12
3  13  14  1  15  16  1  17  18  1
34  22  1  1  3  19  20  1  21  22  2  23  24  3  25  26  1  27  28  3
29  30  1  31  32  1  33  34  1  35  36  1  37  38  1
TIME 2 SECS.

LOCK GROUP
READY

OFF
OFF AT 13:21
PROC. TIME...    2 SEC.
```

There is also a list for File. ONE but since this is only a sample, it is not necessary to include that one also.

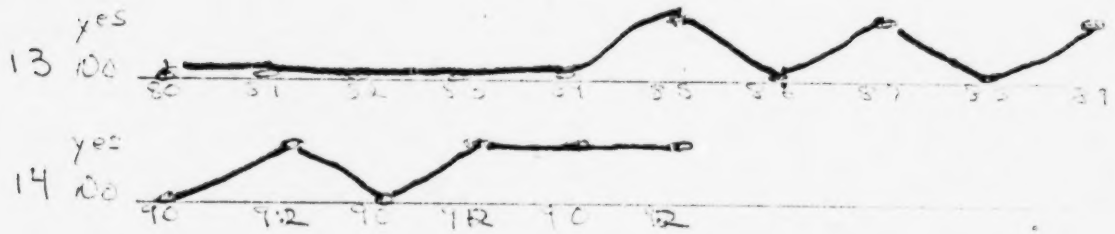
3rd Time

Student No: Group No.

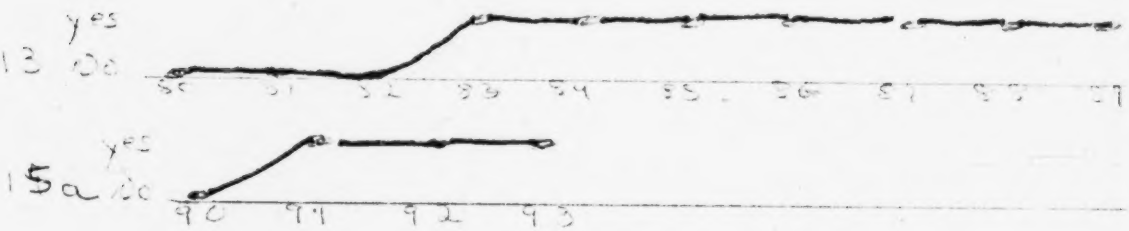
22



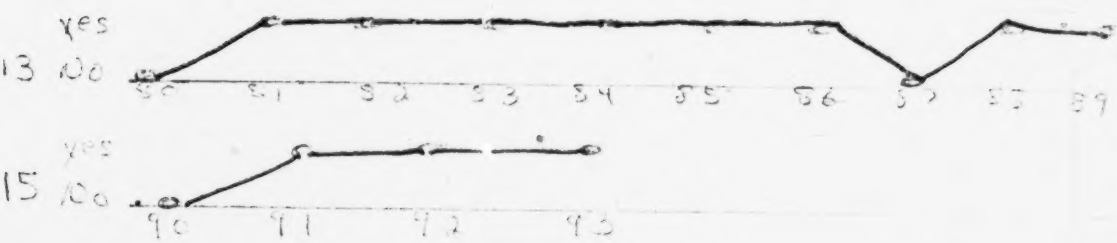
5



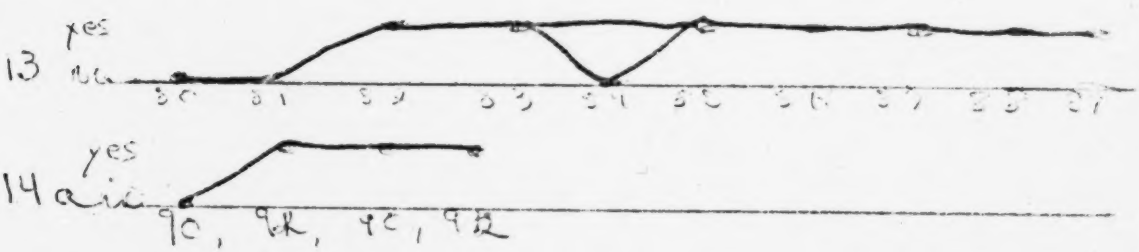
4



65

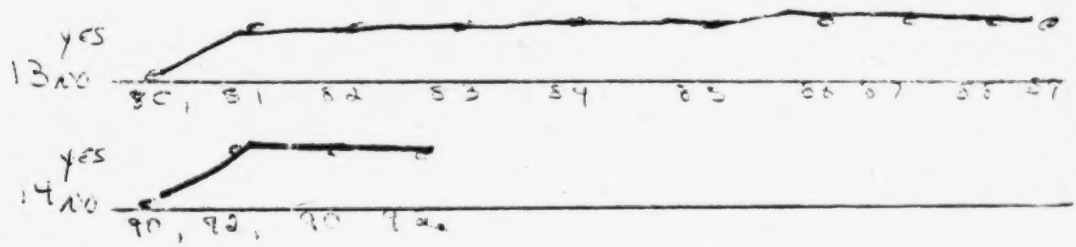


3

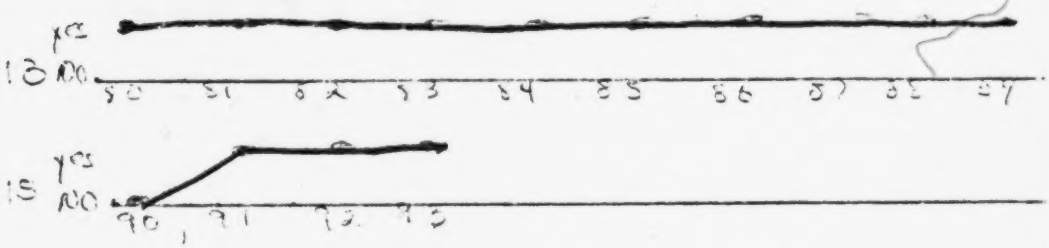


Student No: Group No:

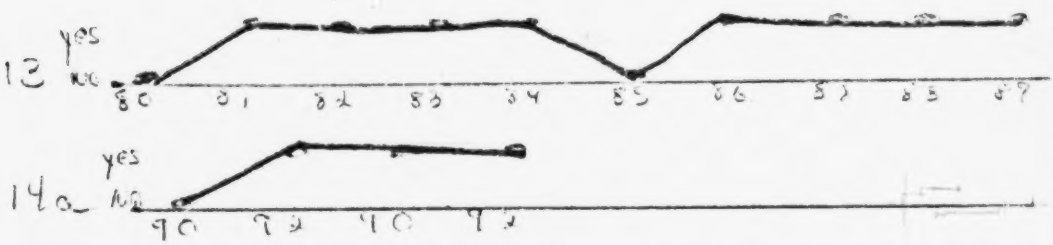
21



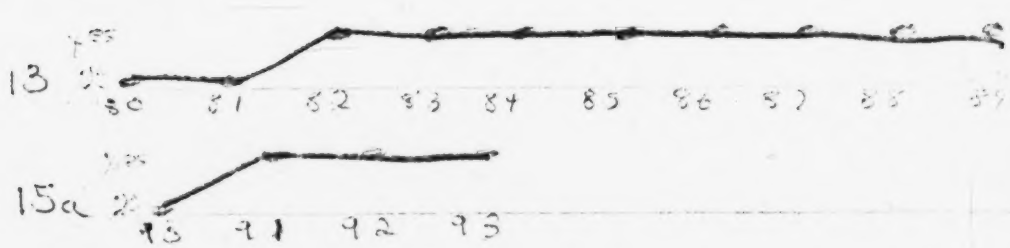
30



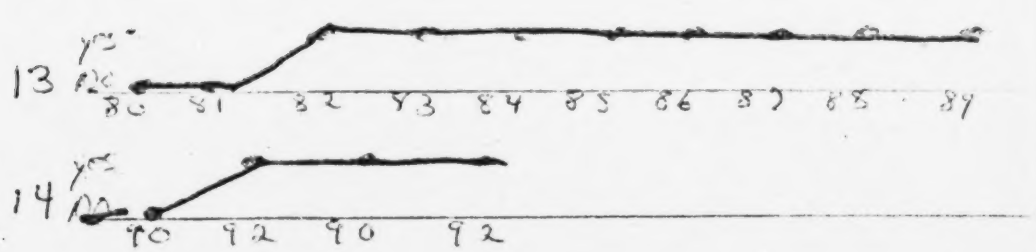
20



39

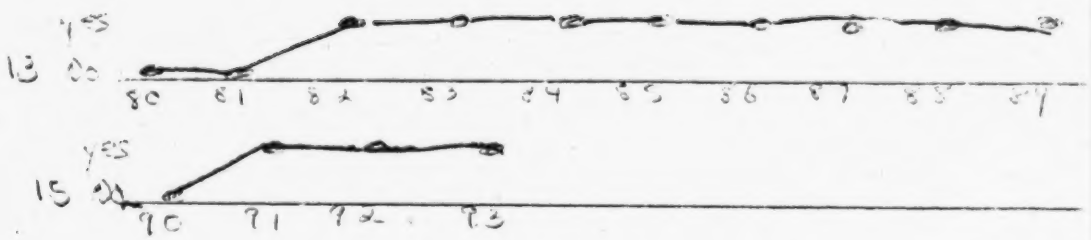


31

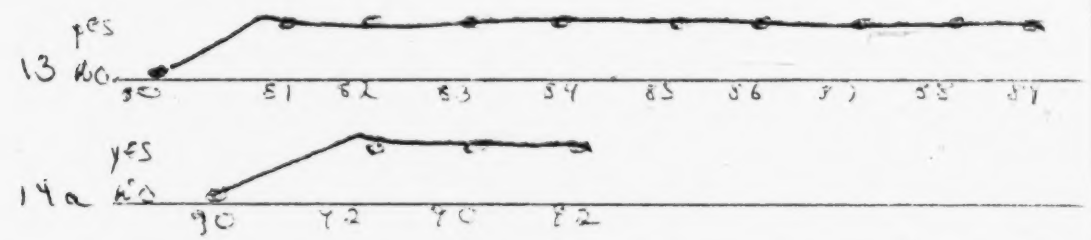


Student ID: Group ID:

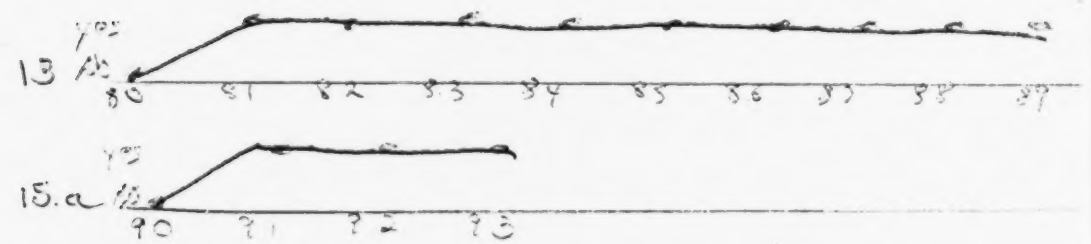
44



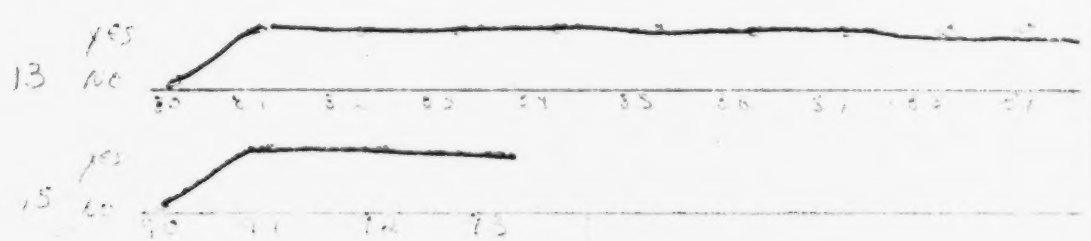
45



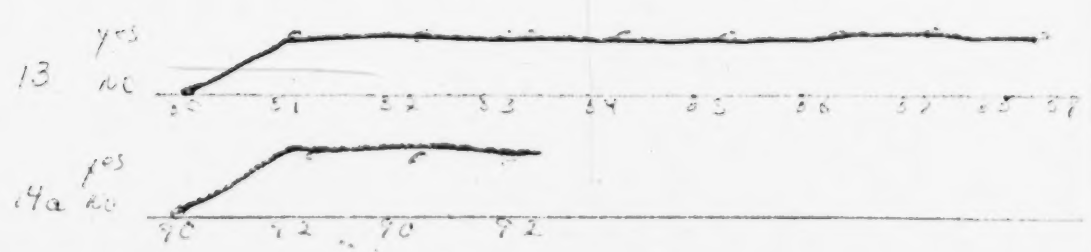
51



47



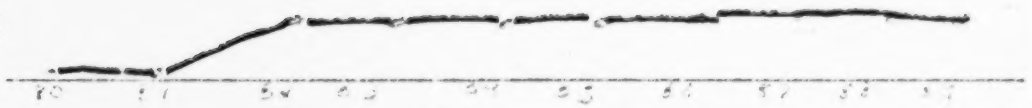
48



Student No. Group No.:

50

13 yes
13 no



15a yes
no

46

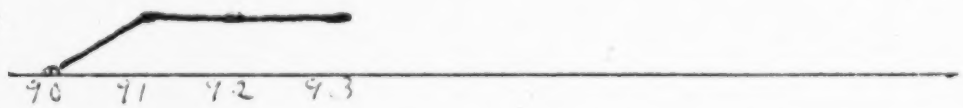
13 yes
no

14 yes
no

13

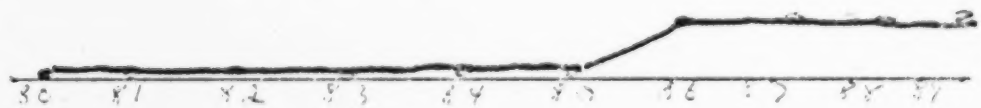
13 yes
no

15a yes
no



36

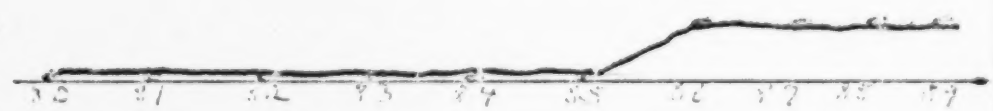
13 yes
no



17 yes
no

61

13 yes
no

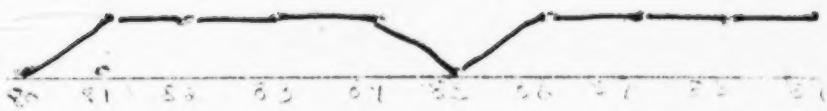


14a yes
no

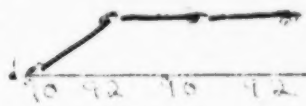
Stream Co: Graph Co:

12

13

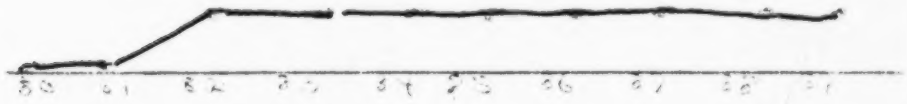


14



15

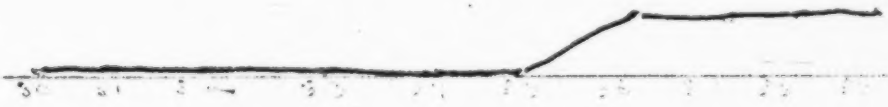
13



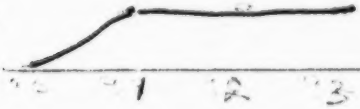
14

29

13



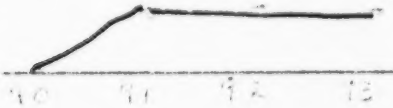
15



16

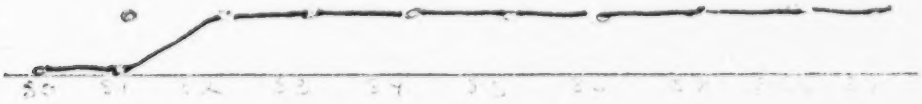
13

15



19

13

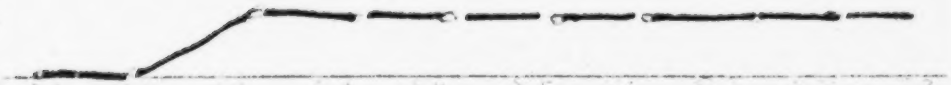


15

Student Graphs

2c

13c



14a

33

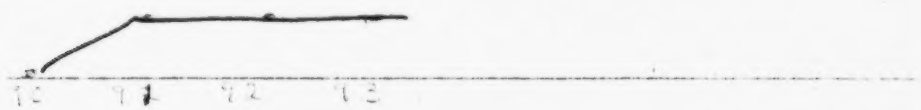
13c

14

55

13c

15a



18

13c

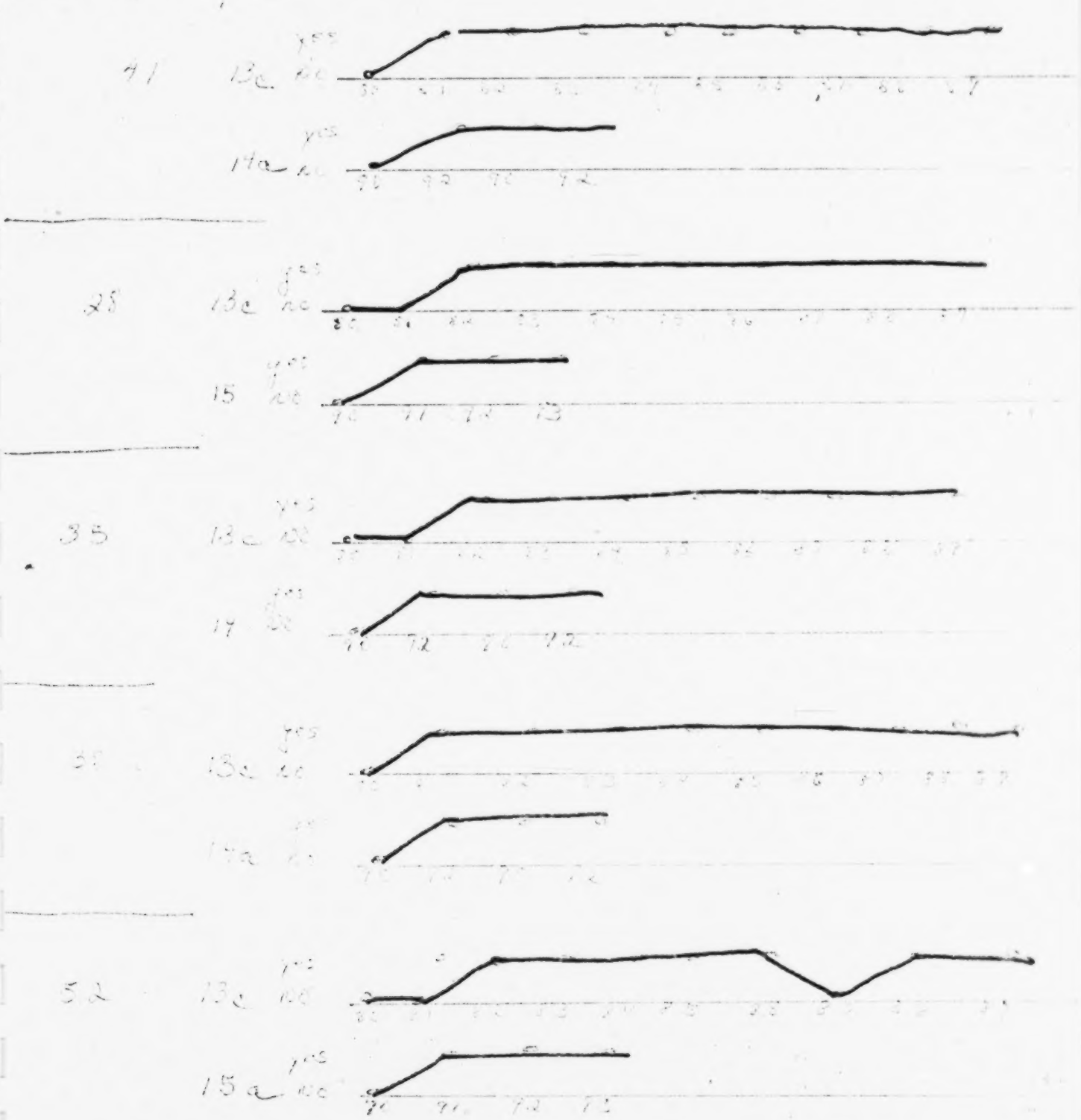
15a

34

13c

15

Student No. Graphs



Shrimp Cocktails

52

13c yes no

15c yes no

14

13c yes no

14 yes no

17

13c yes no

15 yes no

27

13c yes no

12 yes no

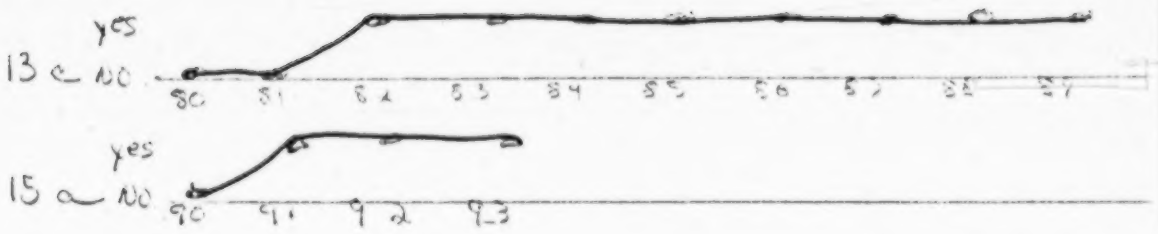
54

13c yes no

14 yes no

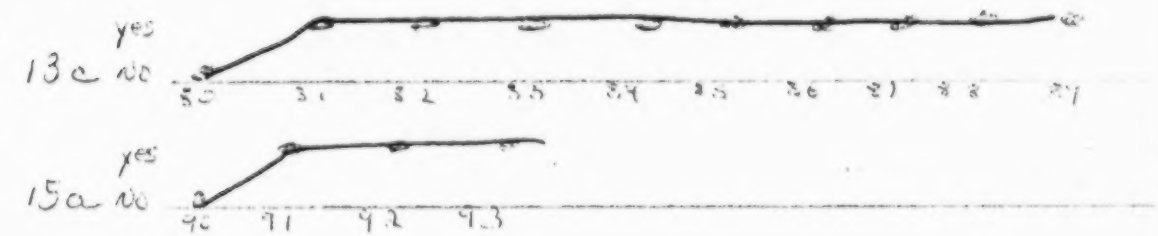
Student No: Group No:

6

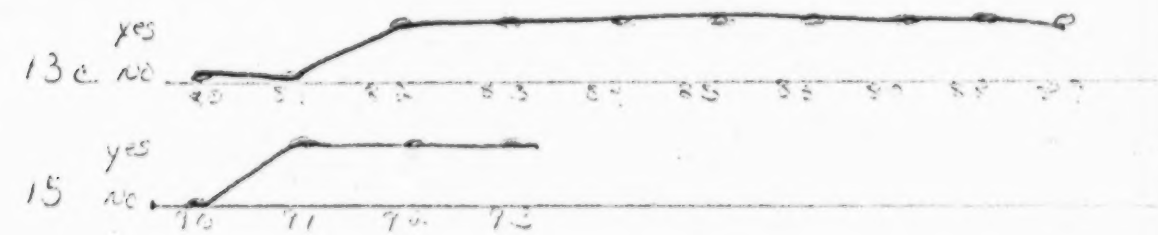


10

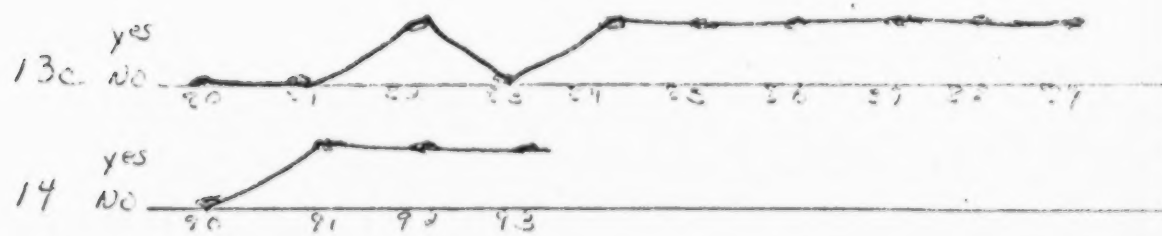
9



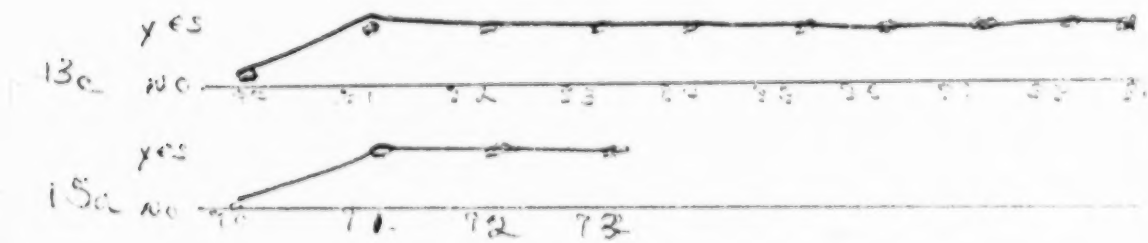
24

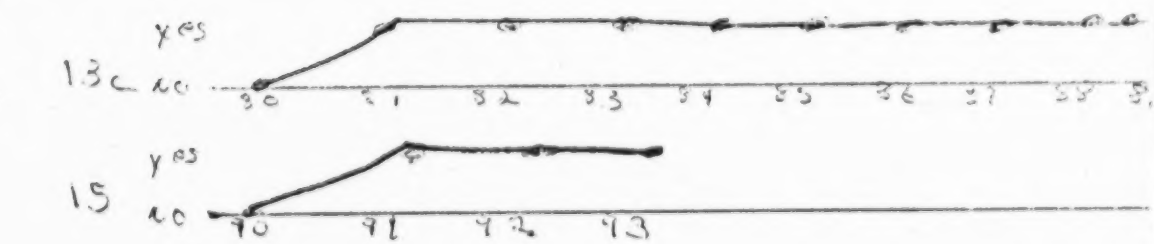


25



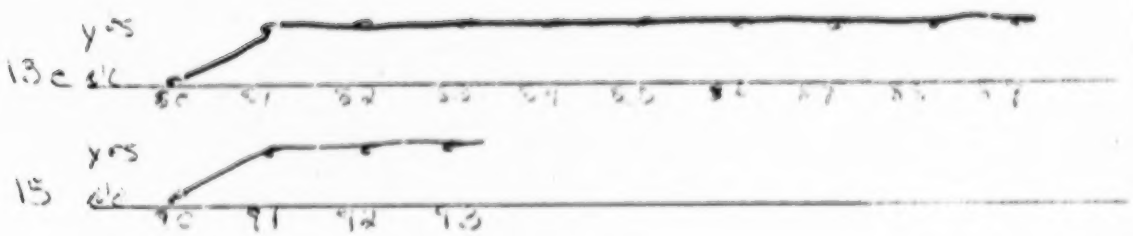
Student ID: Group ID:



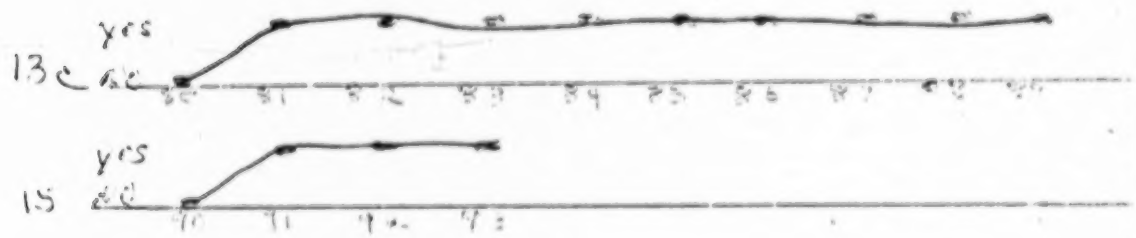


Student No: Group No:

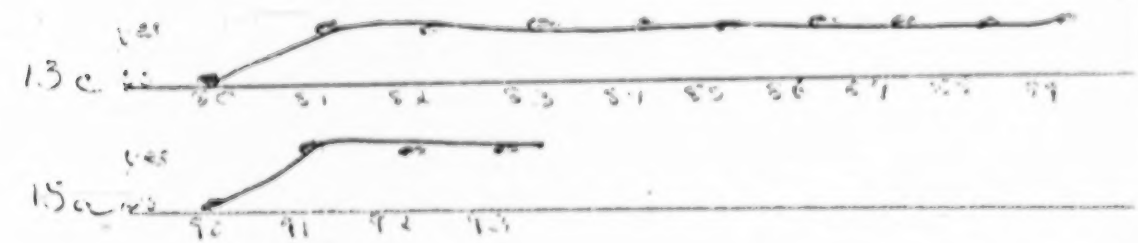
7



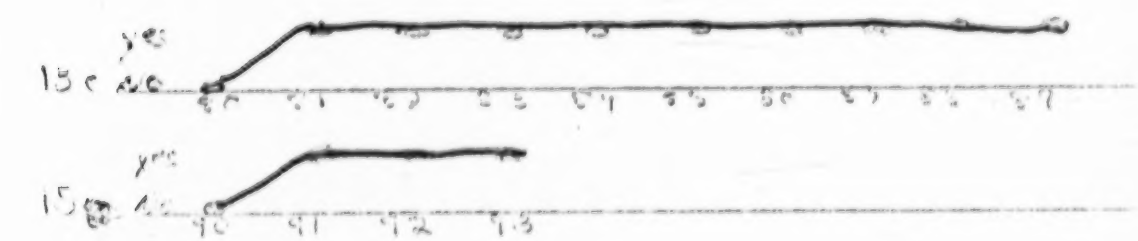
57



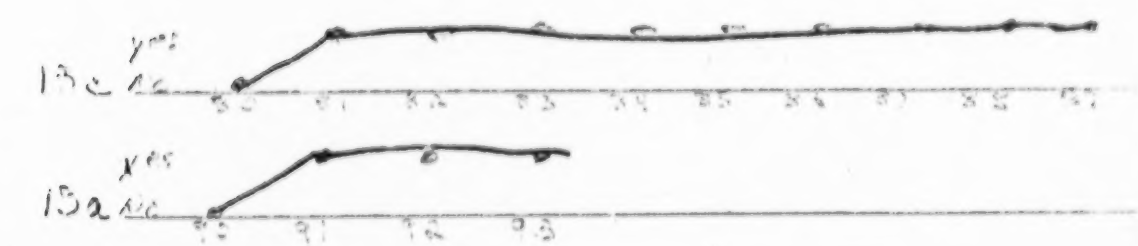
39



80

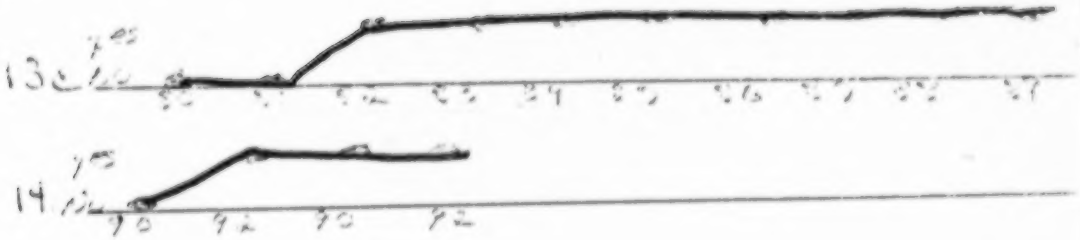


4c.

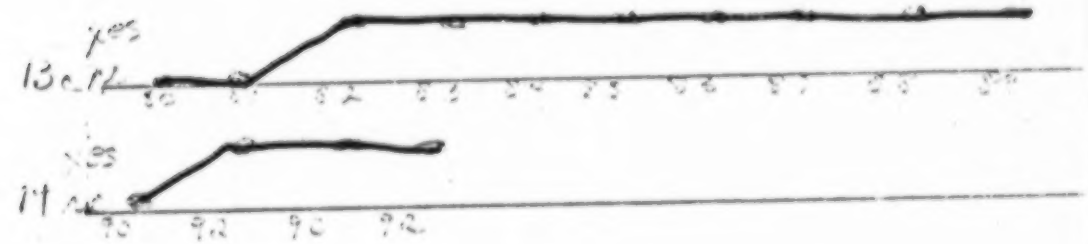


Student No: Group No:

62



64



EXPLANATION AND RESULTS OF WRITTEN TEST I

This test is divided into three parts with four problems in each part. The first problem in each part have a simialr task as well as the second problem, third and fourth. The Research Assistant went into the classroom and handed out a paper with the first four problems on it with the explanation "This is something new, try to give an answer to each problem, but if you cannot do the problems do not worry about it. I will write the answers to the problems on the board when you have passed in this first set to me. You may be able to learn how to do the problems by looking at the answer. Just do the best that you can." After the papers were returned to the Research Assistant and the answers written on the board, the Reaearch Assistant passed out the second set of problems. The same procedure was repeated as was done for the last set of problems. The Research Assistant did this test in all three of the classrooms. The students were noisy but the Research Assistant had no great problems in administering the test except that many of the students did not appear to really care how they asnwered the problems.

The results are graphed on the following pages.

Written Test II

Explanation on following page.

(1) 9Y + 3Y =

(2) -3[illegible] + -4[illegible] =

(3) [illegible] + -3[illegible] =

(4) 9[illegible] + -5[illegible] =

(5) 3[illegible] + 4[illegible] =

(6) -2[illegible] + -[illegible] =

(7) 6A + -9A =

(8) 3[illegible] + -1[illegible] =

(9) 1F + 4F =

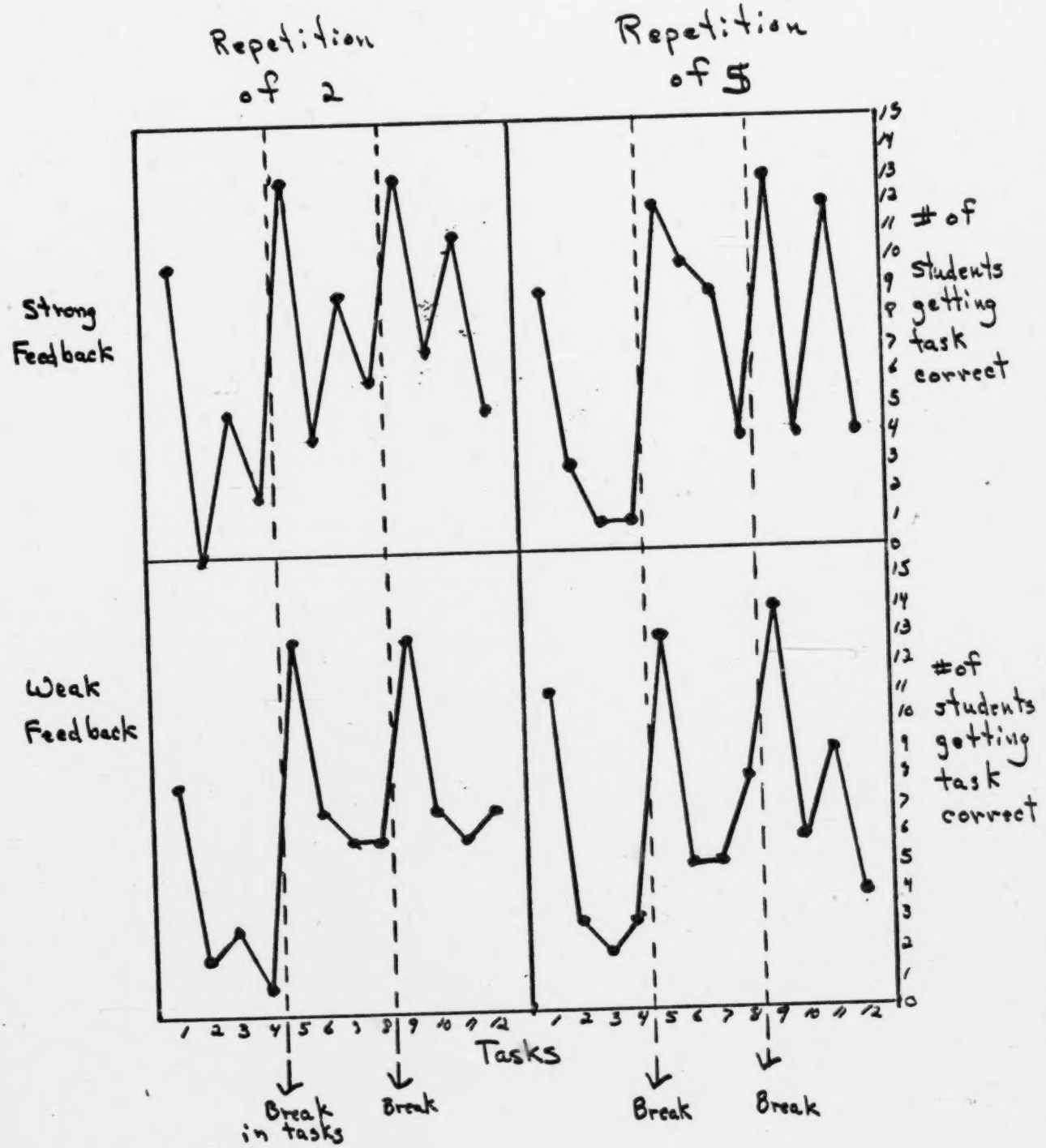
(10) [illegible]B + -2B =

(11) 7Y + -3Y =

(12) [illegible] + -5[illegible] =

Group

Written Test I



Total number doing task for:
Strong feedback - Repetition of 2 → 13
Strong feedback - Repetition of 5 → 13
Weak feedback - Repetition of 2 → 12
Weak feedback - Repetition of 5 → 14

Written Test Cumulatives

I Group

Task #1

	2y + 3y = Rep. 2	Rep. 5	3X + 4X =		1F + 4F		Total		
Strong feedback	10	9	13	12	13	13	71	36	35
Weak feedback	8	11	13	13	13	14	71	34	37
								70	72

Task #2

	-3N + -2N = Rep. 2	Rep. 5	-2R + -4R =		-6B + -2B		TOTAL		
Strong feedback	0	3	4	10	7	4	23	11	17
Weak feedback	2	3	7	5	7	6	30	16	14
								27	31

Task #3

	4A + -3A = Rep 2	Rep 5	6A + -2A =		7Y + -3Y =		TOTAL		
Strong feedback	5	1	9	9	11	12	47	25	22
Weak feedback	3	2	6	5	6	9	31	15	16
								40	38

Task #4

	2X + -5X = Rep 2	Rep 5	3N + -4N =		2R + -3R =		TOTAL		
Strong feedback	2	1	6	4	5	4	22	13	9
Weak feedback	1	3	6	8	7	4	29	14	15
								27	24

TEST II

PART I

#1

$5X + -3X =$ _____

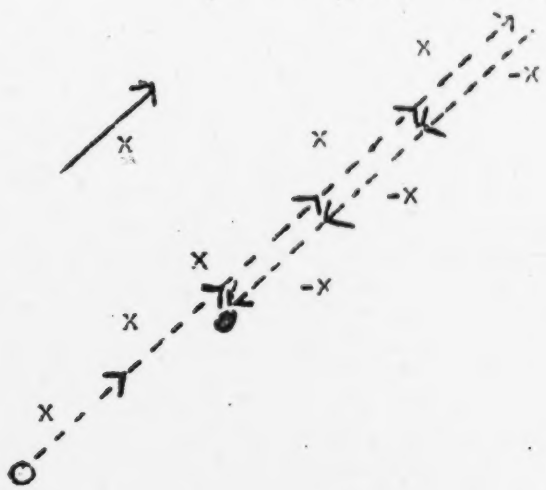
#2

$-4X + 1X =$ _____

#3

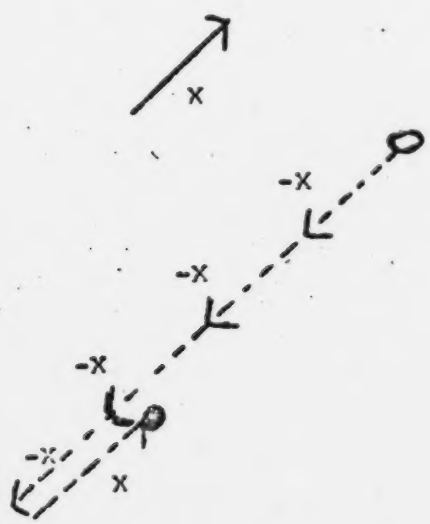
$-2X + -2X =$ _____

#1



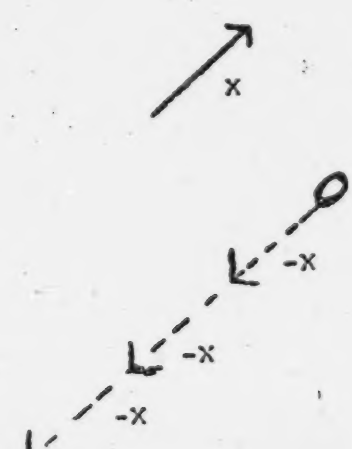
5X + -3X = 2X

#2



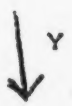
-4X + 1X = -3X

#3



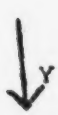
-2X + -2X = -4X

4Y + -2Y = _____



#5

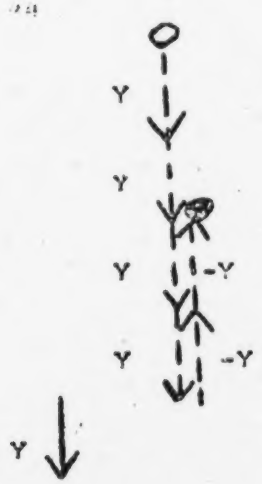
-3Y + 2Y = _____



#6

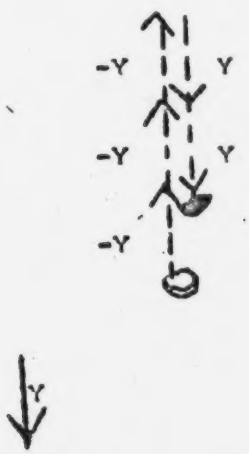
-3Y + -4Y = _____

#4



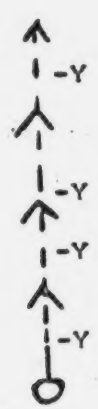
4Y + -2Y = 2Y

#5



-3Y + 2Y = -1Y

#6



-3Y + -1Y = -4Y

FILMED FROM BEST AVAILABLE COPY

17 $5A + -4A =$ _____

18 $-5A + 3A =$ _____

19 $-4A + -2A =$ _____

FILMED FROM BEST AVAILABLE COPY

#7 $5A + -4A = 2A$

#8 $-5A + 3A = -2A$

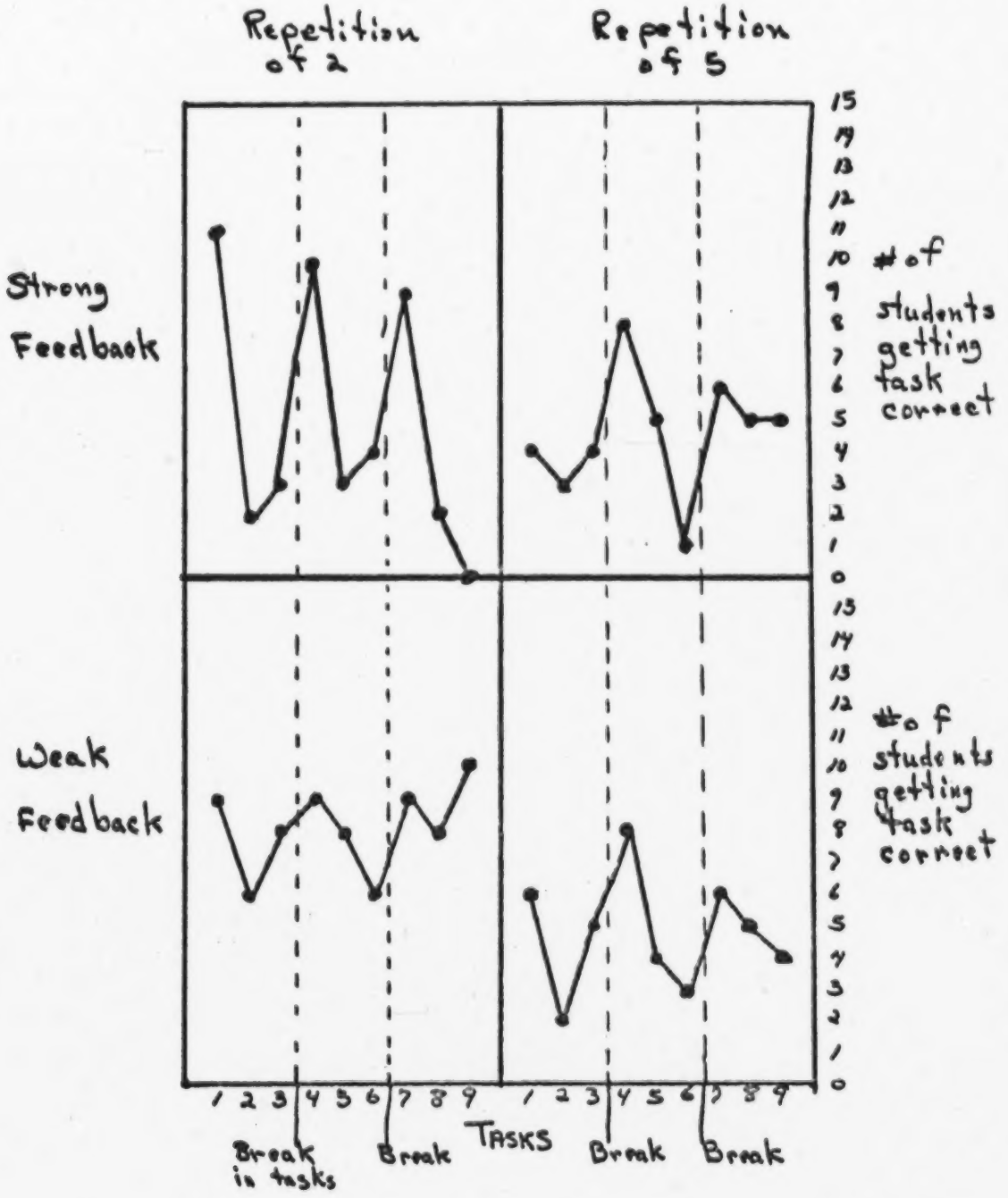
#9 $-4A + -2A = -6A$

First Set of Students

Written Test II

All 3 classes

Group Testing



Total number doing task for: Strong feedback - Rep of 2 → 12
Strong feedback - Rep of 5 → 10
Weak feedback - Rep of 2 → 13
Weak feedback - Rep of 5 → 12

All ~~strategy~~ classes

Total

TASK #1

Strong feedback	11	7	18	30
weak feedback	9	6	9	27
				20

TASK #2

Strong feedback	2	3	5	7
weak feedback	6	2	8	22
				11

TASK #3

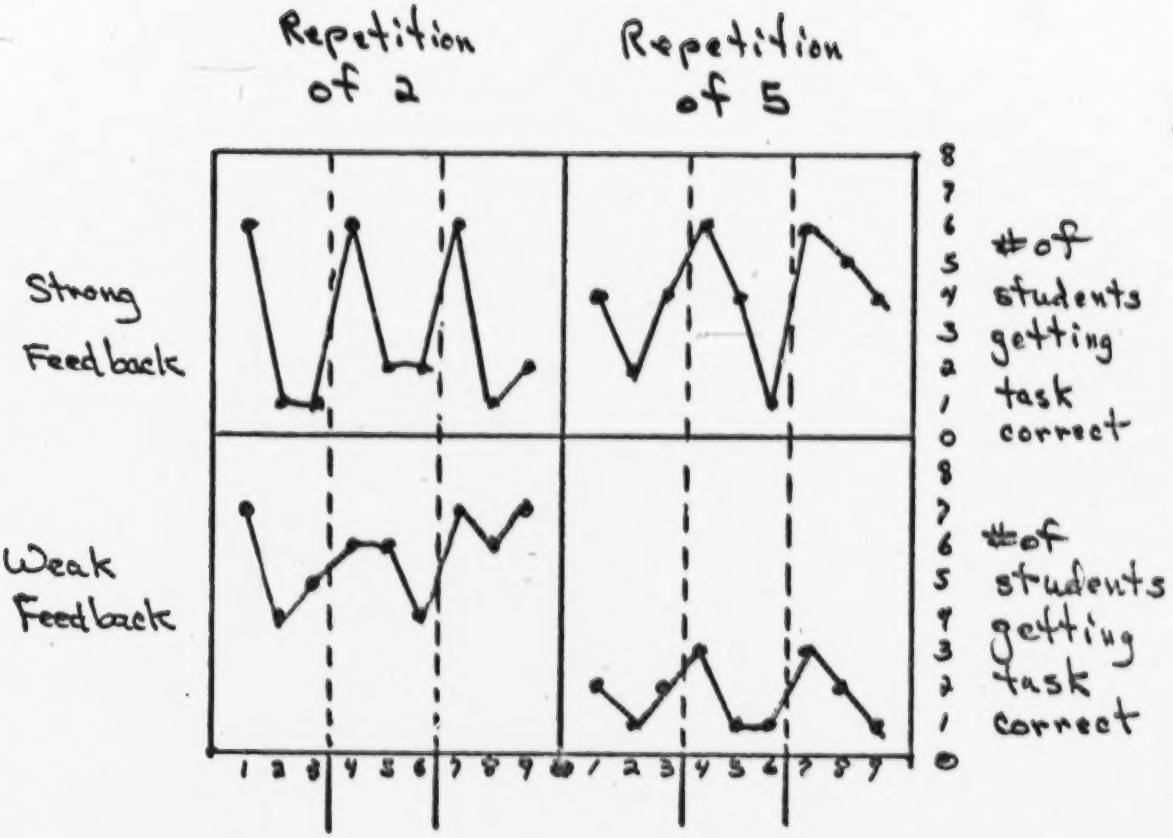
strong feedback	3	4	7	8
weak feedback	8	5	13	24
				12

~~TASK #4~~

~~strong~~ feedback			12	16
			13	
				12

Written Test II

Whalen + Emerson only


Repetition of 2
Repetition of 5
Strong Feedback
Weak Feedback
# of students getting task correct
# of students getting task correct
1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 6 7 8 9

Total number doing task for: Strong feedback - Rep of 2 → 6
Strong feedback - Rep of 5 → 7
Weak feedback - Rep of 2 → 7
Weak feedback - Rep of 5 → 5

Whalen + Emerson Chl

TASK #1

$5x + -3x =$

	Rep 1	Rep 2
Strong feedback	6	4
weak feedback	7	2

1	1
2	3

6	1
1	2

TOTAL

13	11
20	8

TASK #2

$-4x + 1x =$

	Rep 1	Rep 5
Strong feedback	1	2
weak feedback	4	1

$-3y + 2y =$

2	4
6	1

$-5A + 3A =$

1	5
0	2

4	11
16	4

TASK #3

$-2x + -2x =$

	Rep 2	Rep 5
Strong feedback	1	4
weak feedback	5	2

$-3y + -1y =$

2	1
4	1

$-4A + -2A =$

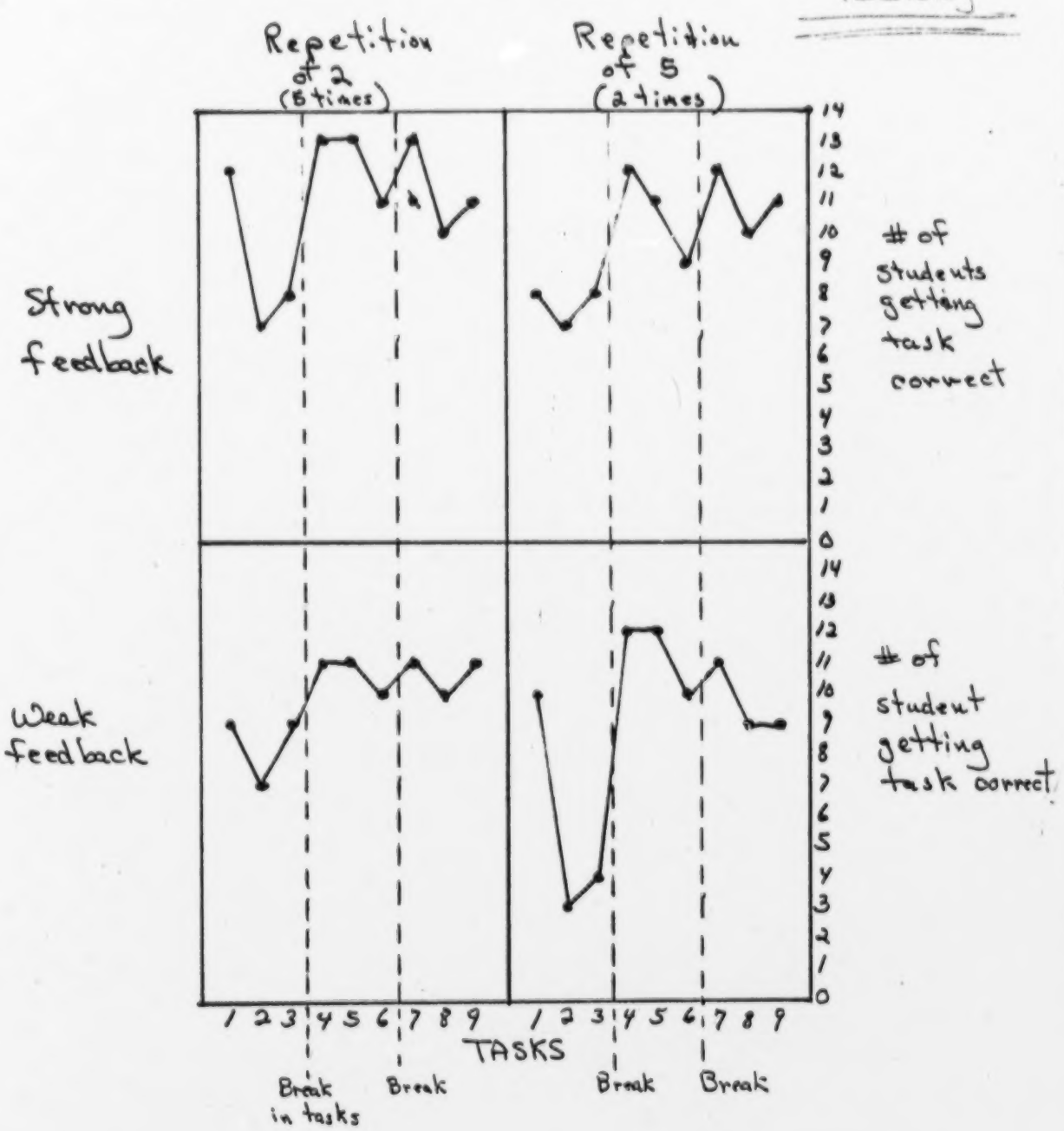
2	4
7	1

5	9
16	4

First Set of Students

Written Test III

Individual Testing


Repetition of 2 (5 times)
Repetition of 5 (2 times)
Strong feedback
Weak feedback
# of students getting task correct
# of student getting task correct
TASKS
1 2 3 4 5 6 7 8 9
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Break in tasks
Break
Break
Break

Total Number doing task for: Strong feed back - Rep of 2 → 14
Strong feed back - Rep of 5 → 12
Weak feed back - Rep of 2 → 12
Weak feed back - Rep of 5 → 13

Written Test Cumulatives
III

TASK #1

$5x + -3x =$

	Rep 2	Rep 5
strong feedback	12	8
weak feedback	9	10

$4y + -2y =$

Rep 2	Rep 5
13	12
11	12

$6A + -4A =$

Rep 2	Rep 5
13	12
11	11

TOTAL

38	32
31	33

TASK #2

$-4x + 1x =$

7	7
7	3

$-3y + 2y =$

13	11
11	12

$8A + -3A =$

10	10
10	9

30	28
28	24

TASK #3

$-2x + -2x =$

8	8
9	4

$-3y + -1y$

11	9
10	10

$-4A + -2A =$

11	11
11	9

30	28
30	23

Written Test Differences
III

TASK #1

	Round 1+2 Rep 2	Round 1+2 Rep 3	Round 2+3 Rep 2	Round 2+3 Rep 3	Round 1+3 Rep 2	Round 1+3 Rep 3	[illegible]
Strong feedback	1	4	0	0	1	4	
Weak feedback	2	2	0	-1	2	1	

TASK #2

Strong	6	4	-3	-1	3	3		
Weak	4	9	-1	-3	3	6		

TASK #3

Strong	2	1	2	2	3	3		
Weak	1	6	1	-1	2	5		

Suggestions

Before continuing the research, the Research Assistant would like to make the following suggestions of changes that might be made.

1) Group 13 is a multiple choice type of problem. The students did not understand the multiple choice portion of the problem and actually did not use it in giving their answers. It is suggested that this group have an answer similar to the others.

2) Blanks have been placed on problem pages supposedly to show the students that an answer is required of them at this spot. The students do not know what the blank is for and have often tried to use it for another vector. It is suggested that this blank be omitted.

3) The arrow over the letters, that designate the name of a vector confuses the students. It is not needed and therefore should be omitted leaving only the letter to name the vector. The students tried to use this little arrow as a another vector. The students were confused by it and the Research assistant had to explain to them its purpose.

4) All letters that are on the page should be typed. Also the answers that the students tell the Research Assistant could be typed on the terminal so that the students can compare their answers with those of the computer's.

CHANGES

The following changes have been made in the program. The reasons for some of the changes are explained in the page entitled Suggestions.

1) Group 13 is no longer multiple choice.

2) There are no blanks on the problem page designating the answer.

3) All letters on the problems and the answer sheets have been typed for easier reading by the students.

4) A different set of instructions are given to the students for Groups 10 through 23 that Groups 1 through 9. Because the tasks are different there is a need for this separate set of instructions. The set of instructions for Groups 1 through 9 are the following (SET A):

EACH PICTURE IS A PROBLEM. PLEASE POINT TO A PLACE ON THE PAGE WHICH IN YOUR OPINION IS THE CORRECT ANSWER. THE COMPUTER WILL TELL YOU WHETHER YOU WERE RIGHT ON THE CORRECT ANSWER, CLOSE TO IT, OR TOO FAR OUT. REMEMBER _ A CORRECT ANSW FOLLOWS EACH PROBLEM.

The set of instructions for Groups 10 through 23 are the following (SET B):

AFTER TYPING "YES" TO THE QUESTION READY? MADE BY THE COMPUTER, TYPE THE ANSWER THAT BEST DESCRIBES THE PROBLEM. THE COMPUTER WILL TELL YOU WHETHER YOU WERE RIGHT ON, QUITE CLOSE, OR TOO FAR OUT. THE COMPUTER WILL THEN PRINT THE CORRECT ANSWER. (ENTER ALL POSSIBLE ANSWERS).

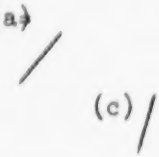
At this time the Research Assistant still answers by pressing #1 (right On), #2 (Quite Close), or #3(Too Far Out), For Groups 10 through 23 the Research Assistant will also type in the correct answer after the computer prints Quite Close or Too Rar Out. In these groups, the student must type in the answer after he types YES to the computer's question READY? as stated in the directions. No answer sheet is given for these groups unless strong feedback is utilized.

5) Changes have been made in Group 99 to utilize both sets of instructions and to show the student how to use the typewriter portion of the terminal. The Instructions for Group 99 will be the following:

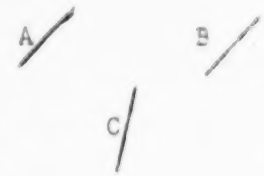
FOR PROBLEMS 1, 2, 3. PLEASE POINT TO WHAT YOU THINK IS THE CORRECT ANSWER. FOR ALL THE REST, JUST TYPE THE ANSWER YOU THINK IS BEST AFTER THE COMPUTER ASKS: READY AND YOU HAVE TYPED: YES.

The students will have to be shown how to erase (use of arrow) and when to type their answers. Also the choice of lines (tasks) 1 - 9) are done by using the letters A, B, and C as names of the lines; example:

before: (a) (b) (c)



Now: A B C



This is similar to later problems when the student must name the vectors.

6) The program has been changed so that before each group the computer will ask if the student wants instructions. This is in place of the computer giving instructions before each group. The purpose of this is to save time.

7) Groups 24, 25, and 26 have been added to the program. They utilize SET B of the instructions where the student has to point to the correct answer. The task is for the student to use an algebraic statement and arrive at a point. A sample of the task is the following:

Problem:

$2x + -1y$

or

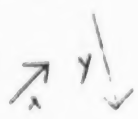
$-1y + 2x$

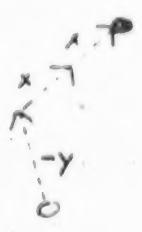
Answer: (with strong feedback)

$2x + -1y$

or

$-1y + 2x$





8) It was decided to not use all of the groups when starting a new set of students but only those that appeared necessary by the findings given. On the following page is a list of the groups to be used with the new set of students.

Groups Abbreviated

The following groups will be used by the second set of students to try out this program. The number of groups used is fewer than previously used because some of the groups were found to be unnecessary. Group 99 (the prerequisite for the program) will also be given.

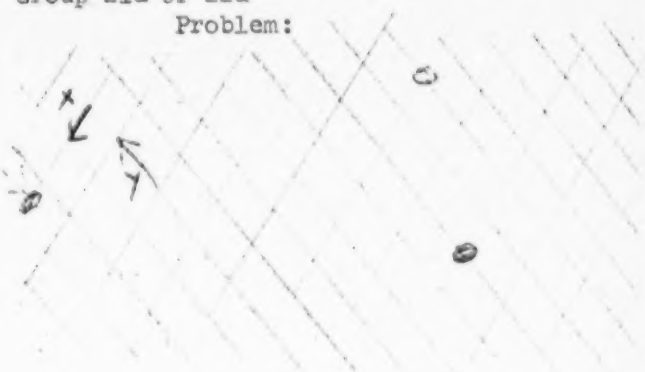
GROUP 3a or 4a

Problem:

Answer:

Group 21a or 22a

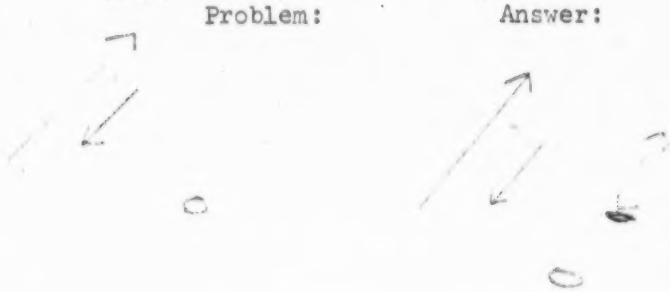
Problem:



GROUP 8a or 9a

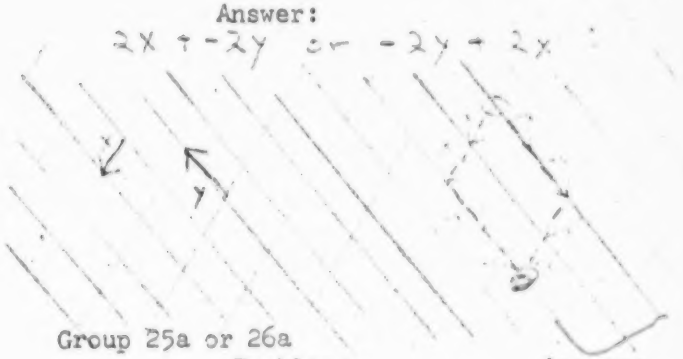
Problem:

Answer:



Answer:

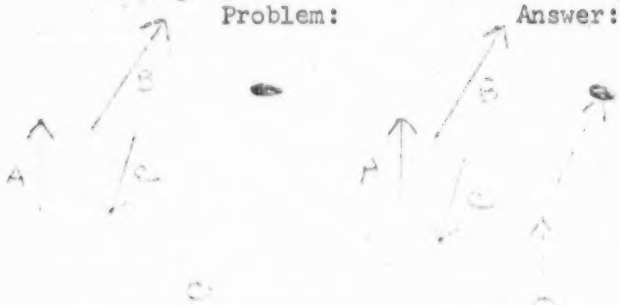
$2x + -2y$ or $-2y + 2x$



Group 13a

Problem:

Answer:



Group 25a or 26a

Problem:

Answer:

$2x + -1y$

or

$-1y + 2x$

Group 18a or 19a

Problem:

Answer:

$-x + -x + -x =$

$-3x$

Title: Learning Difficulty, Transfer and Retention in Concept Formation Tasks in Mathematics

Grant No: OEG-1-71-0018 (509)

INTERIM REPORT

General Findings

(a) The sequence of tasks works with fourth, fifth and sixth graders when used with a research assistant (who stimulates a graphic terminal and a computer terminal).

(b) It is feasible to carry on such research in a modern, project-centered classroom without disturbing ongoing activities.

(c) Increasing automatization of the process, moving toward the complete automatization visualized in the original proposal, does not reveal any significant problems in this area.

(d) There seem to be graphic terminals which will handle the complete automatization when funds become available for this.

(e) One general instructional effect of the wordless sequence, stressing as it does the use of feedback as guidance, is to bring the learners to rely on feedback to direct their next responses, and to expect to receive feedback concerning each response; this is noticed by the research assistant during the course of working with the students (in the role of graphic display, of course), but it is possible in the future to test this hypothesis by pre-exposure of an experimental group to different tasks relying on feedback, and then comparing their performance on the initial task of this sequence with that of learners who have not had comparable previous experience. (There are other ways to test it as well.)

(f) We are finding that what seems to be a logical sequence of tasks involving steps or transfers of equal difficulty turns out in practice to be highly irregular in this regard; i.e., our ability to predict what will be a difficult step and what will not is very poor. Thus we are approximating an optimal sequence of tasks, i.e., a sequence which is the shortest one possible which will maintain a high success rate, through empirical data, taking out steps where there seems to be no difficulty and at the same time noting where information was left out which was needed but overlooked by the programers. Through this experience I expect to be able to draft a preliminary calculus of instructional variables and test its generality by applying it to another sequence; namely, a sequence in adding-subtracting and multiplying-dividing for younger children.

Particular Findings:

(a) Number of repetitions (amount of variagion) has no effect on learning according to the data gathered from the various tasks of the program itself, in terms of trials-to-criterion.

(b) Strength of feedback is crucial in an early, foundation-concept type task (adding of two factors in two-space), but has no effect in subsequent tasks.

NOTE: Both (a) and (b) may indicate that the sequence is not optimal, i.e., the "step-size" has been too small to bring out any differences except in the one initial task where strength of feedback was necessary--i.e., learners did not "get it" without strong feedback. This can also be looked upon, incidentally, as the establishment of a mediator, i.e., drawing the dotted arrow in the answer gives them a mental process whereby to find the final position from the initial position.

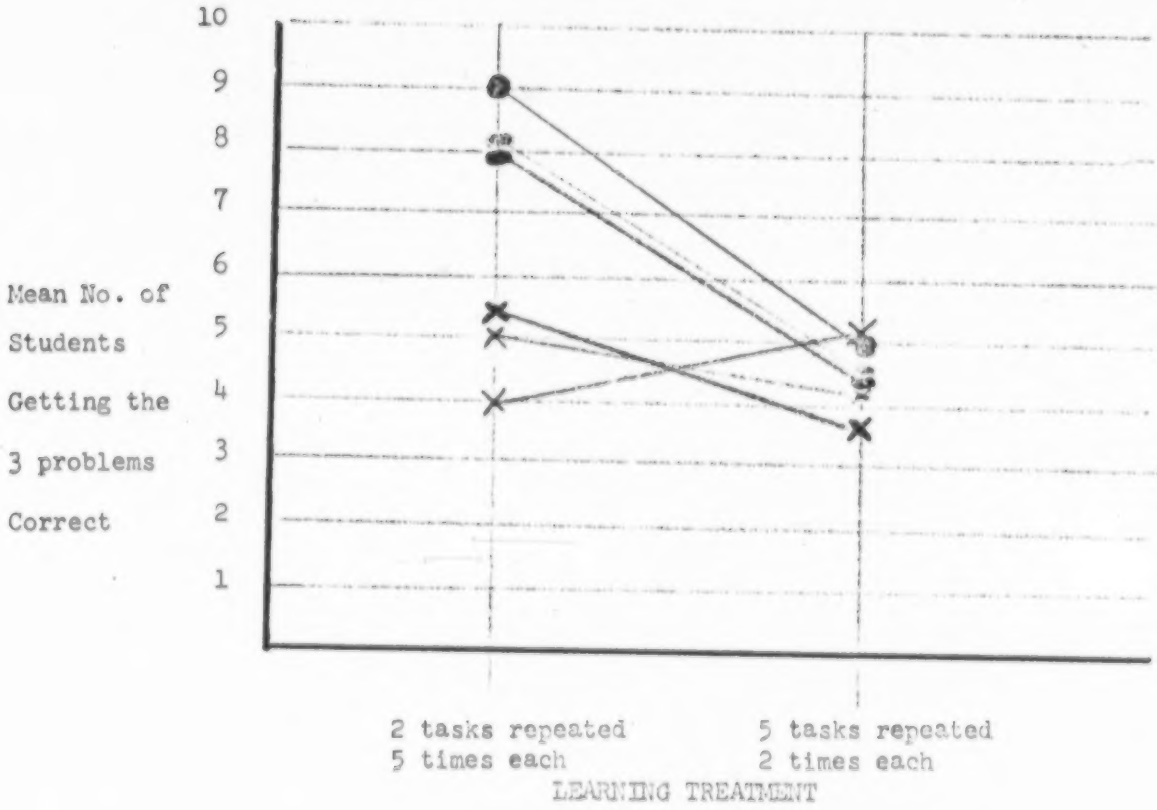
(c) Data from each stage indicate that a one-trial learning process was taking place, i.e., when the learner "got it," he continued to respond accurately, rather than varying between right and wrong answers. Furthermore, most learners "got it" on the first or second task in most cases, occasionally needing the feedback from the first, seldom that from the second. This also can be interpreted as supporting and insight-based theory of learning (similar to one-trial, and compatible with mathematical stimulus sampling theories except that we have no normal distribution of trials-to-insight).

NOTE: There is no indication, therefore, from the learning data that having the learners do ten tasks at each stage was effective. However, since it was necessary to do this in order to give one group five repetitions of two different tasks and the other group two repetitions of five different tasks at each stage, we followed through with this in the first phase. (The second phase, in progress now, has been limited to five tasks, where either five different tasks are given, or two tasks with one repeated twice and the other repeated three times; the same variables are being used, to try to replicate findings from the first phase.)

(d) Data from an immediate post-test indicate no differences among the various groups or interactions; this post-test was given individually, in the same mode as the learning tasks, with feedback after each task. However, instead of each task being repeated several times, the test gave four different types of task one after the other, then went through those four again, and then once more.

(e) A delayed post-test similar to that in (d) was administered to the class as a group, in school, rather than individually. This caused some negative feelings from the group, but most of them cooperated. (These classes do not use group work very often.)

STUDENTS CORRECTLY DOING TASK AS RELATED TO LEARNING TREATMENT



This delayed post-test indicated a difference between strong and weak feedback groups when there were two tasks repeated five times each, but no difference when there were five tasks repeated two times each. Thus it seems that the weak-feedback situation compared with the strong in a manner similar to the comparison of guided discovery to guidance alone, but that this only happened when the stimulus variation was sufficiently low, i.e., when the variation was not so high as to make discovery too difficult. This hypothesis could explain the lack of observable differences between treatments during learning, where the support given by the programed sequence was so great that it covered up the fact that the weak feedback group had developed its own mediators. This was brought out when the "artificial" mediators extinguished or were less accessible (being newer responses) after a time.

General Conclusions:

It seems worthwhile to continue to investigate the present variables for the time being; the most recent results indicate some significant outcomes are possible, and we need to replicate the original experiment with larger numbers. At the same time we are investigating graphic terminals and hope to find some combination which will enable us to completely automate the process without additional funds. However, it seems likely that we will need to apply for more extensive funding to go into that kind of context.

What may emerge from this is some initial notion of the opmimal amount of repetition or variation of examples of a given type of task, interacting with guidance (strength of feedback), or variation of examples of a

type of task, in respect to (a) learning speed, (b) retention, and (c) transfer. The learning speed is measured by trials to criterion at a given stage; the transfer is measured partly by learning on subsequent stages and partly by a delayed test which utilizes the learned process as a mediator; and the retention is measured by comparing immediate and delayed test results.

At the same time we are dealing with these variables, we are also dealing with two other very important ones; namely, optimal step-size or length of sequence or difficulty, and the matter of absolute number of tasks done at each stage, regardless of reaching criterion, i.e., "drill" or "over-learning." In the latter the question is whether it is important to continue to do tasks of a given type after reaching criterion--whether the repetition adds something. The fact that we have some differences among our treatments indicates that there <u>is</u> a potentially significant effect of drill beyond "understanding," but we need to go into this extensively before we can say anything about it in a reliable fashion.

NEW SET OF STUDENTS

RESULTS FOR SECOND SET OF STUDENTS

Strong Feedback - Repetition of 2 (5 times)

Groups Administered: 99, 3a, 9a, 13ad, 18a, 21a, 25a
Students Participating in Series: 10
Outcome: All students understood the tasks

Strong Feedback - Repetition of 5 (2 times)

Groups Administered: 99, 4a, 8a, 13ac, 19a, 22a, 26a
Students Participating in Series: 10
Outcome: All students understood the tasks

Weak Feedback - Repetition of 2 (5times)

Groups Administered: 99, 3a, 9,13d, 18, 21, 25
Students Participating in Series: 10
Outcome: All students understood the tasks

Weak Feedback - Repetition of 5 (2 times)

Groups Administered: 99, 4a, 8, 13c, 19, 22, 26
Students Participating in Series: 11
Outcome: All students understood the tasks

RESULTS EXPLAINED

This second set of students also came from the Oyster River Elementary School in Durham, N.H. They are fourth, fifth, and sixth graders who are in the traditional school setting. Permission slips were sent home for the parents to sign and those students who volunteered for the program were taken to Morrill Hall in the Education Department of the University of N.H. Each student had to go through a series consisting of seven groups; therefore, the Research Assistant could not put more than one student in the morning and one in the afternoon through the program. This resulted in the number of students in this portion of our research to be lower than would have been preferred. For a short period of time the Research Assistant was using two terminals set up in the terminal room in Morrill Hall. This worked out very well and although it made a lot of work for the Research Assistant (because of the way the program is written at this time - the Research Assistant has to say whether each problem is correct or not.) the ability to do two students at a time was a great time saver. This would have been continued except that the TV terminal broke down and had to be sent away to be repaired.

The students were divided into four groups as shown on the previous page of the results. All students succeeded in understanding the tasks; therefore, showing no major differences in performance. The Research Assistant timed the students while they did the program and the average for the two groups who used strong feedback was 56.3 minutes and the average for the two groups using the weak feedback was 82.4 minutes. This is a significant difference. The Research Assistant suggests using only strong feedback because of this time difference. The students often

get tired especially after a seven group series.and the shorter it is for them the more willing they would be to complete or at least do more of the program. This will probably become more evident as the program becomes longer.

The students appeare to need all of the groups used; therefore, this same series will be used for the next set of students. Only a few of the students went through all 10 tasks in each group - this does not appear to be necessary. Once the student has "figured out" how to do a group he is anxious to see what is next. This also allows for a shorter time for working.

There was one student in this set who could not understand the tasks in group 99 and therefore did not finish the program.. When her teacher was questioned, it was found that this student has perceptual problems and is being counciled at school for them.

WRITTEN TEST IV

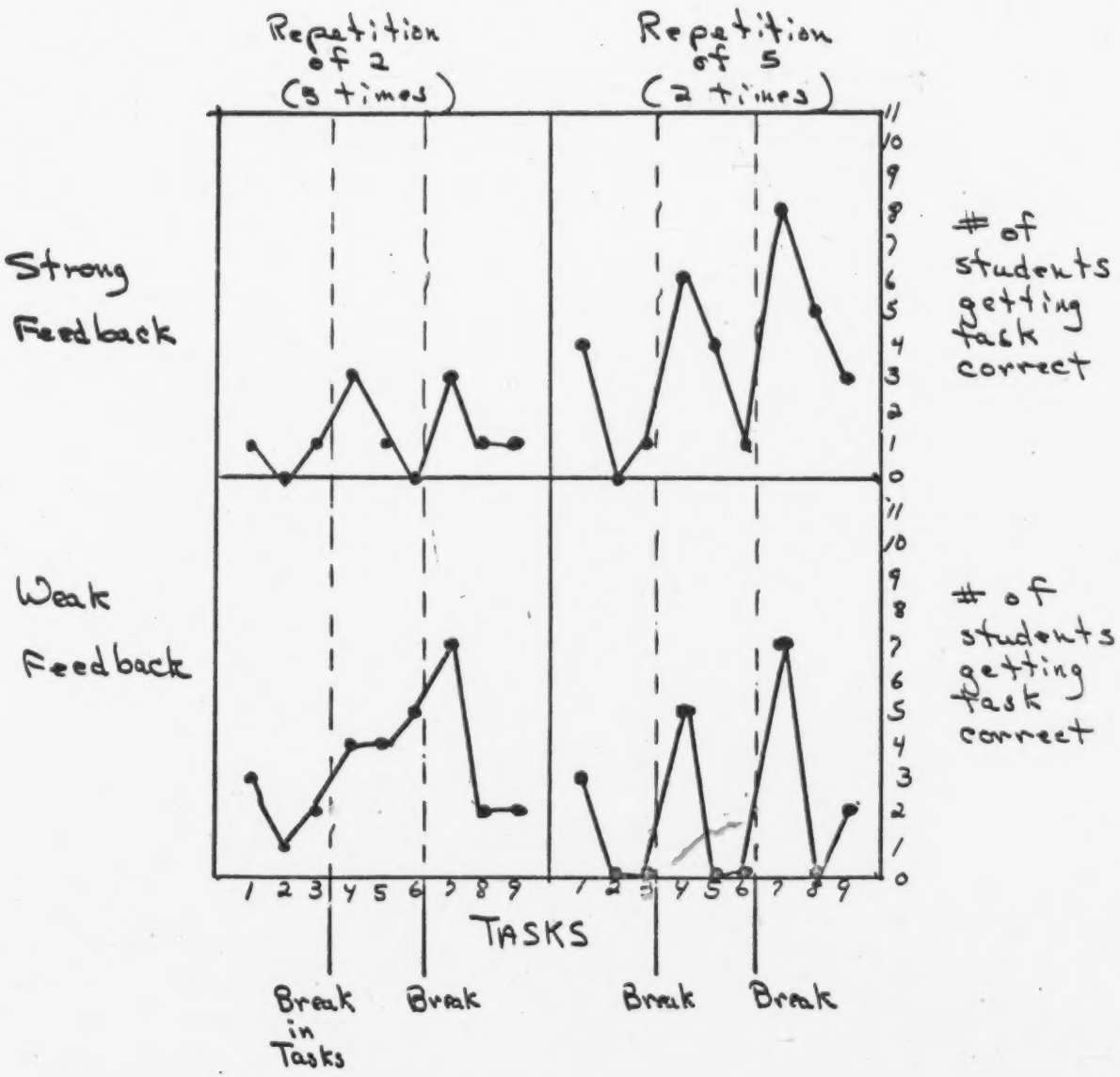
The same test that was administered to the old set of students was given to this new set. The test was fiven in both a group setting and individually. The results of both tests are graphed on the following pages. The students still did better on the individual testing than the group test.

NOTE: There were 10 students,all from one class that the Research Assistant was unable to group test because of lack of time. There still should be enough data to see results.

Test II

Test on New Student Group (2nd)

Group Test



Total Number doing task for:
Strong Feedback - Repetition of 2 → 3
Strong Feedback - Repetition of 5 → 10
Weak Feedback - Repetition of 2 → 11
Weak Feedback - Repetition of 5 → 7

Test Cumulatives

Group Test

TASK #1

5x + -3x =

	Rep 2	Rep 5
Strong redback	1	4
Weak redback	3	3

4y + -2y =

Rep 2	Rep 5
3	6
4	5

6A + -4A =

Rep 3	Rep 5
3	8
7	7

Total

Rep 2	Rep 5
7	18
14	15

TASK #2

-4X + 1x =

Strong	0	0
Weak	1	0

-3y + 2y =

4	4
4	0

-5A + 3A =

1	5
2	0

2	9
7	0

TASK #3

-2x + -2x =

Strong	1	1
Weak	2	0

-3y + -1y =

0	1
5	0

-4A + -2A =

1	3
2	2

2	5
9	2

Total Participating → 31

	Rep 2	Rep 5
SF	3	10
WF	11	7

Test Differences

Group test

Task #1

	Round 1+2		Round 2+3		Round 1+3	
	Rep 2	Rep 5	Rep 2	Rep 5	Rep 2	Rep 5
Strong Feedback	2	2	0	2	2	4
Weak Feedback	1	2	3	2	~~5~~	4

Task #2

Strong	1	4	0	1	1	5
Weak	3	0	-2	0	1	0

Task #3

Strong	-1	0	1	2	0	2
Weak	3	0	-3	2	0	2

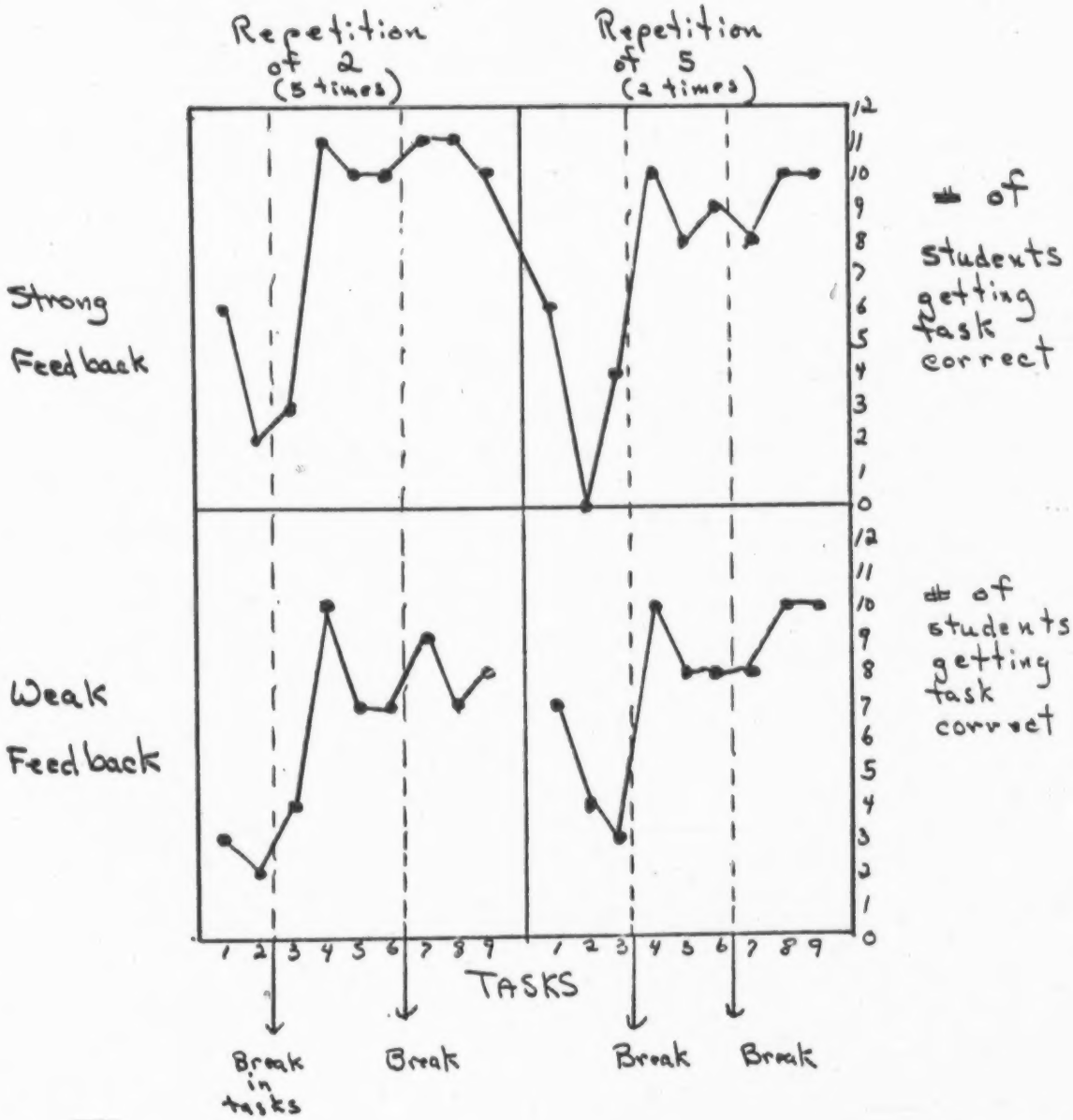
Total Participating → 31

	Rep 2	Rep 5
SF	3	10
WF	11	7

Test on New Student Group (2nd)

Individual Test

Test V



Total Number doing task for: Strong feedback - Repetition of 2 → 11
Strong feedback - Repetition of 5 → 10
Weak feedback - Repetition of 2 → 11
Weak feedback - Repetition of 5 → 10

Test Cumulatives

Individual Test

TASK #1

$5X + -3X =$

	Rep 3	Rep 5
Strong Feedback	6	6
Weak Feedback	3	7

$4Y + -2Y =$

Rep 3	Rep 5
11	10
10	10

$6A + -4A =$

Rep 3	Rep 5
11	8
9	8

Total

Rep 3	Rep 5
28	24
22	25

TASK #2

$-4X + 1X =$

Strong	2	0
Weak	2	4

$-3Y + 2Y =$

10	8
7	8

$-5A + 3A =$

11	10
7	10

23	18
16	22

TASK #3

$-2X + -2X =$

Strong	3	4
Weak	4	3

$-3Y + -1Y$

10	9
7	8

$-4A + -2A =$

10	10
8	10

23	23
19	21

~~Totals~~ Total Participating ↓

	Rep 3	Rep 5
SF	11	10
WF	11	10

42 students

Test Differences

Individual Test

Round 1+2

	Rep 2	Rep 5
Strong Feedback	5	4
Weak Feedback	7	3

Round 2+3

	Rep 2	Rep 5
Strong Feedback	0	-2
Weak Feedback	-1	-2

Round 1+3

	Rep 2	Rep 5
Strong Feedback	5	2
Weak Feedback	6	1

TASK #1

TASK #2

Strong	8	8
Weak	5	4

9	12	
0	2	

9	10
5	6

TASK #3

Strong	7	5
Weak	3	5

0	1
1	2

7	6
4	7

Total Participating — 42 students

	Rep 2	Rep 5
SF	11	10
WF	11	10

THIRD SET OF STUDENTS

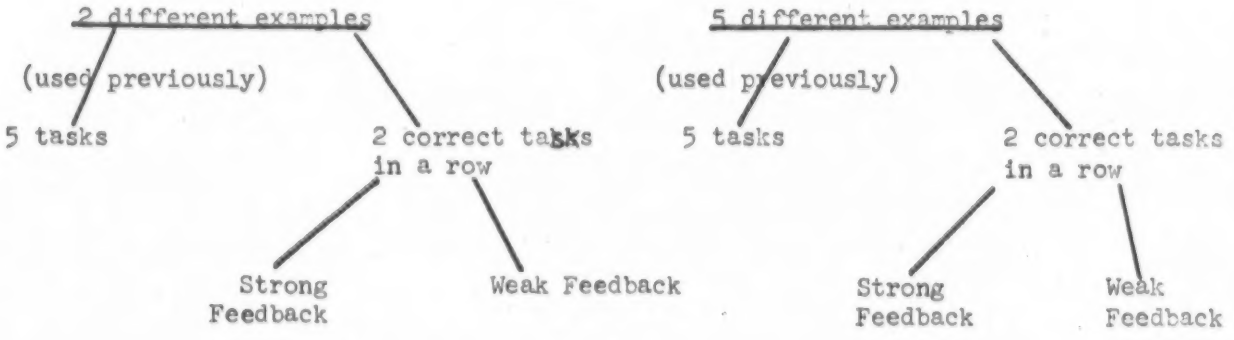
This set of students comes from the Hilltop Elementary School (Summer School) in Somersworth, N.H. The students will be entering the fourth, fifth, sixth, and seventh grades in the fall.

A DigiLog Telecomputer Terminal (TV Terminal) has been rented and is set up at the Hilltop School. It was necessary to have a Centrix telephone line installed for the purpose of contacting the computer at UNH. The school's television is being used. The Research Assistant was given a room to use for the project. The room is spaceous and comfortable and all of the materials will be left right at the school until the research is completed.

The students will be put through one of the following series:

GROUPS: 99,3a,8,13c,18,21,25
99,3a,8a,13ca,18a,21a,25a
99,4a,9,13d,19,22,26
,99,4a,9a,13ad,19a,22a,26a

The following diagram will be an explanation of the procedure to be followed during this set of students:



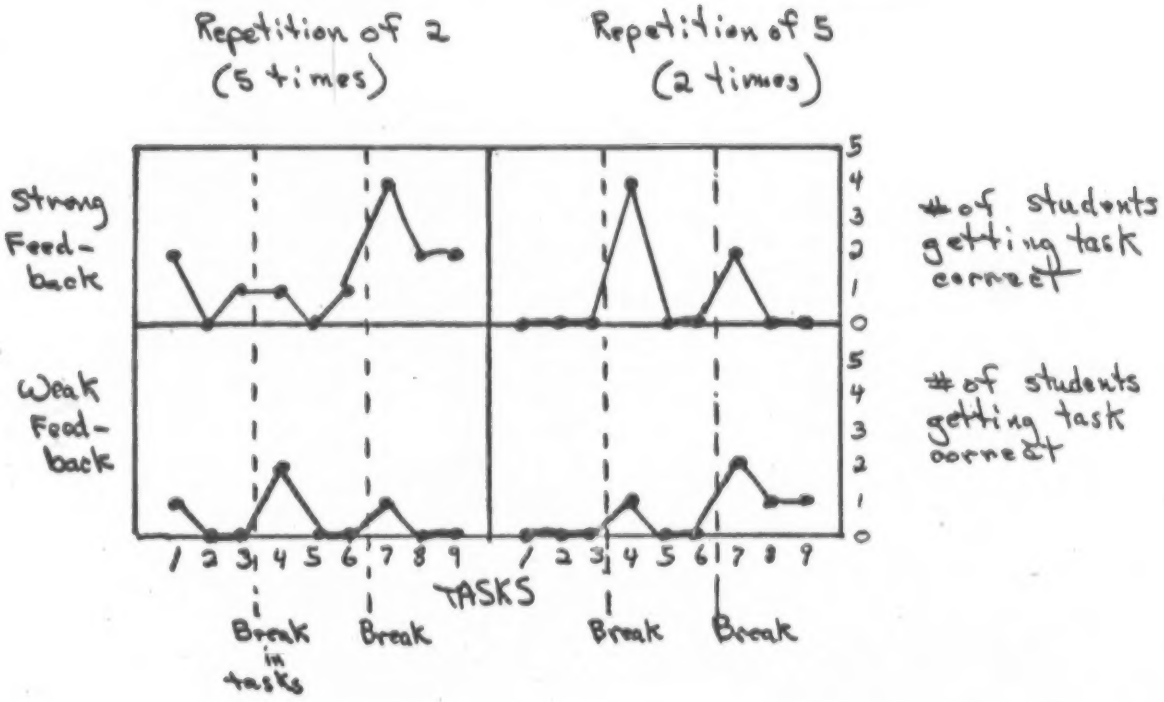
Since a time difference was noticed in the last set of data, this will also be closely watched. The students will be given both group and individual tests as was administered previously.

It is possible for the Research Assistant to take two students per day. The summer school's hours are from 9:00 - 11:30 AM Tuesday through Friday. The students will continue to receive a reward (lollypop) for their work.

Test II

Test on student Group 3

GROUP TEST



Total Number doing task for: Strong Feedback - Repetition of 5 → 5
Weak Feedback - Repetition of 5 → 3
Strong Feedback - Repetition of 2 → 5
Strong Feedback - Repetition of 2 → 5

Two students taking test but not going through program:

TASKS	1	2	3	4	5	6	7	8	9
Andy	-	-	-	✓	-	-	-	✓	-
Nancy	✓	-	-	✓	-	-	✓	-	-

✓ = got task correct
- = got task incorrect

Test Cumulatives

Group Test

TASK #1

5x + -5y =

	Rep 2	Rep 5
strong Feedback	2	0
Weak Feedback	1	0

4y + -2y =

Rep 2	Rep 5
0	0
0	0

6A + -4A =

Rep 2	Rep 5
1	0
0	0

Total

Rep 2	Rep 5
3	0
1	0

TASK #2

-4x + 4x =

strong	1	4
Weak	2	1

-3y + 2y =

	0	0
	0	0

-5A + 3A =

	1	0
	0	0

	2	4
	2	1

TASK #3

-2x + -2x =

Strong	4	2
Weak	1	2

-3y + -1y =

	2	2
	0	1

-4A + -2A =

	2	0
	0	1

	8	2
	1	4

Total Participating = 18

	Rep 2	Rep 5
SF	5	5
WF	5	3

Test Differences

Group Test

TASK #1

	Round 1+2 Rep A	Round 1+2 Rep B	Round 2+3 Rep A	Round 2+3 Rep B	Round 1+3 Rep A	Round 1+3 Rep B
Strong Feedback	-2	0	1	0	-1	0
Weak feedback	-1	0	0	0	-1	0

TASK #2

Strong	-1	-4	1	0	0	-2
Weak	-2	-1	0	0	-2	-1

TASK #3

Strong	-2	-2	0	0	-2	-2
Weak	-1	-1	0	0	-1	-1

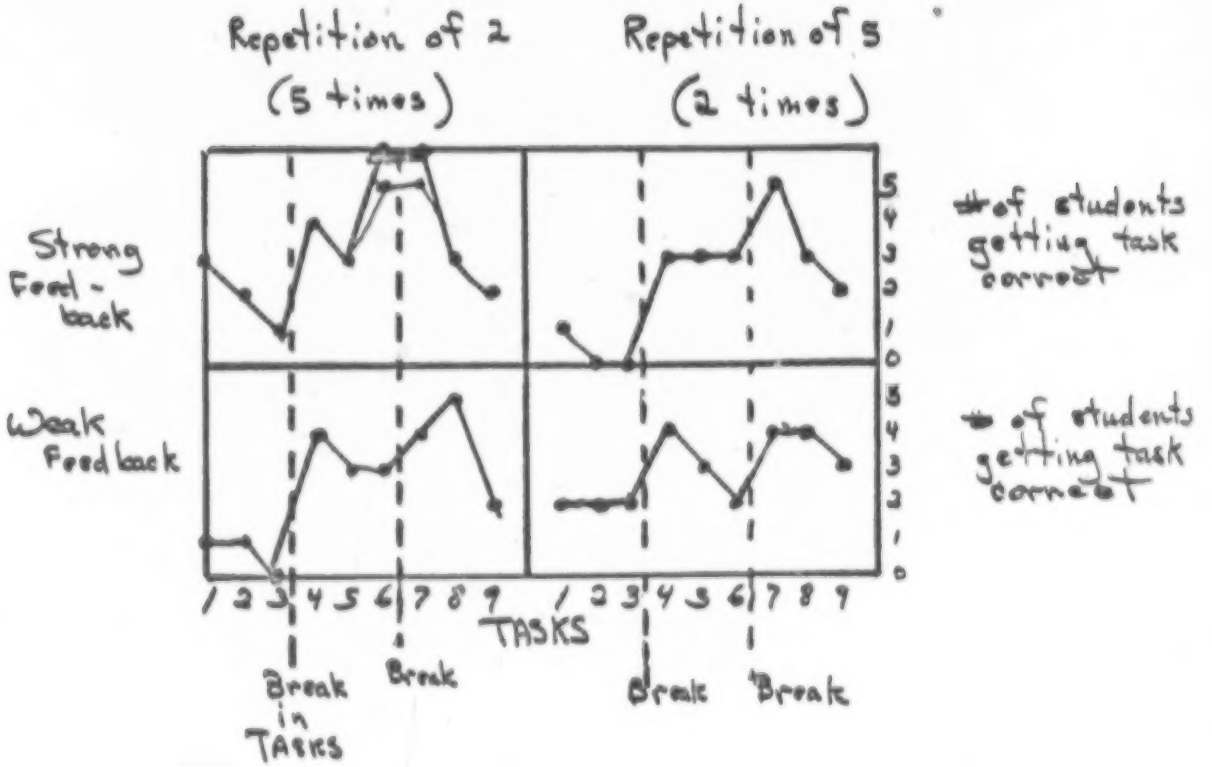
Total Participating = 18

	Rep A	Rep B
SF	5	5
WF	5	3

Test III

TEST ON STUDENT GROUP 3

INDIVIDUAL TEST



Total number doing task for: Strong Feedback - Repetition of 2 — 5
Strong Feedback - Repetition of 5 — 5
Weak Feedback - Repetition of 2 — 5
Weak Feedback - Repetition of 5 — 4

Two student taking test but not going through program:

Tasks	1	2	3	4	5	6	7	8	9
Andy	✓	–	–	✓	✓	✓	✓	✓	✓
Nancy	✓	✓	✓	✓	✓	–	✓	–	–

✓ = got task correct
– = got task incorrect

Test Cumulatives

Individual Test

TASK #1

$6x + -3y =$

	Rep 2	Rep 5
Strong Feedback	3	1
Weak Feedback	1	2

$4y + -2y =$

Rep 2	Rep 5
4	3
4	4

$6A + -4A =$

Rep 2	Rep 5
5	5
5	4

Total

Rep 2	Rep 5
12	9
10	10

TASK #2

$-4x + 2x =$

Strong	2	0
Weak	1	2

$-3y + 2y =$

3	3
3	3

$-5A + 3A =$

3	3
5	4

8	6
9	9

TASK #3

$-2x + -2x =$

Strong	1	1
Weak	0	2

$-3y + -1y =$

5	3
3	2

$-4H + -2H =$

2	2
2	3

8	6
5	7

Total Participating = 19

	Rep 2	Rep 5
SF	5	5
WF	5	4

Test Differences

Individual Test

TASK #1

	Round 1+2		Round 2+3		Round 1+3	
	Rep 2	Rep 5	Rep 3	Rep 5	Rep 2	Rep 5
Strong Feedback	1	2	1	2	2	4
Weak Feedback	3	2	1	0	4	2

TASK #2

Strong	1	3	0	0	1	3
Weak	2	1	2	1	4	2

TASK #3

Strong	4	2	-3	-1	1	1
Weak	3	0	-1	1	2	1

Total Participating = 19

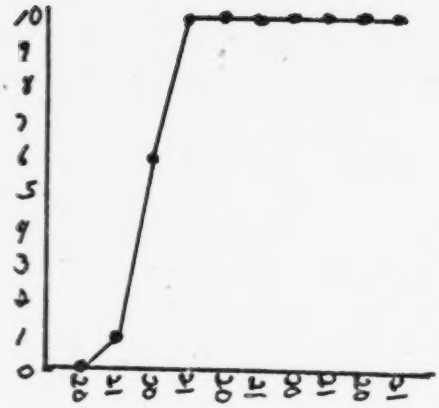
	Rep 2	Rep 5
SF	5	5
WF	5	4

Learning Data

Student Group 3

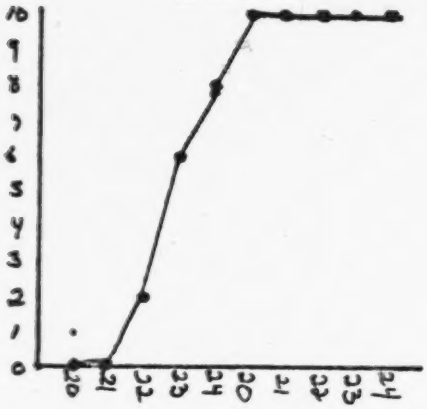
Group 3a

# of students getting task correct



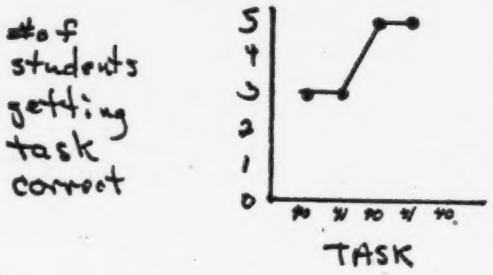
Group 4a

# of students getting task correct

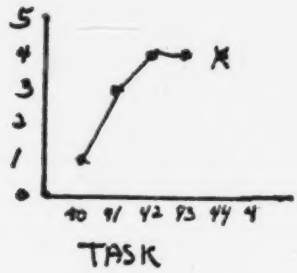


Learning Data

Group 9

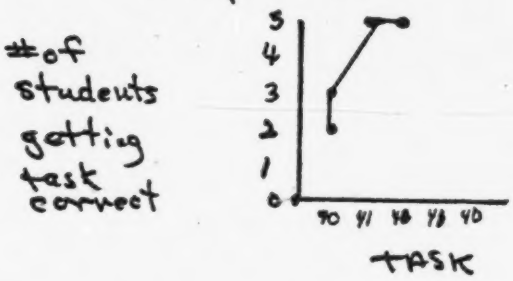


Group 8

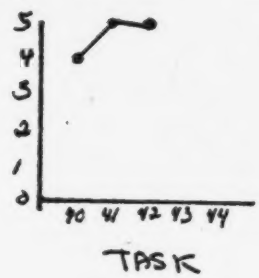


1 student got 6 X

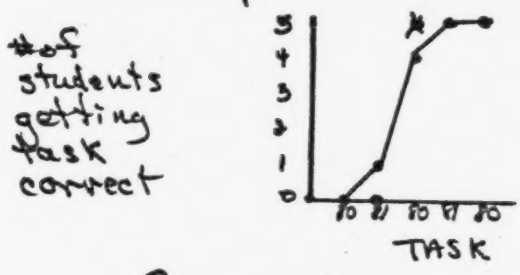
Group 9a



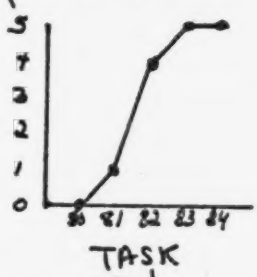
Group 8a



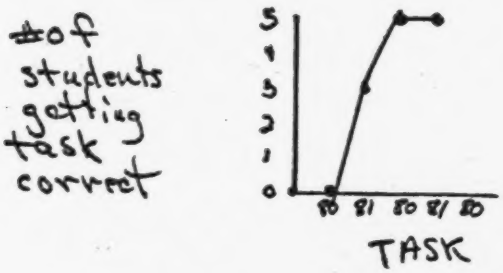
Group 13c



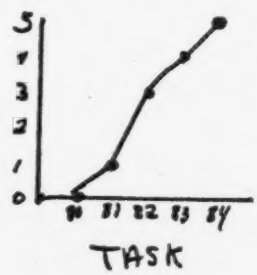
Group 13d



Group 13ca

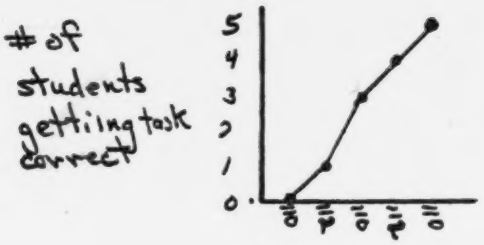


Group 13da

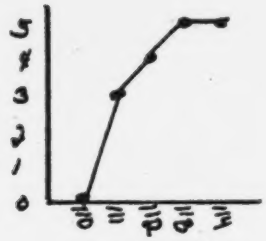


Learning Data

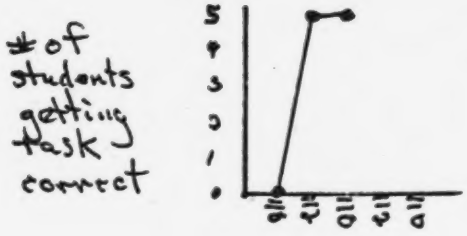
Group 18



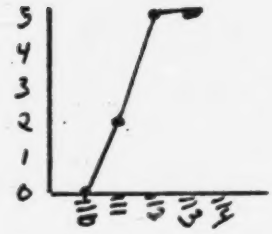
Group 19



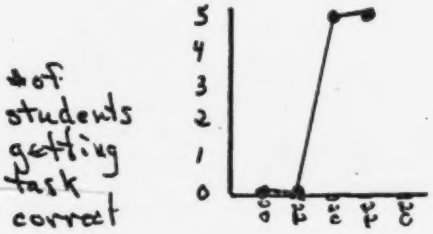
Group 18a



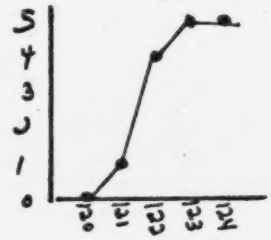
Group 19a



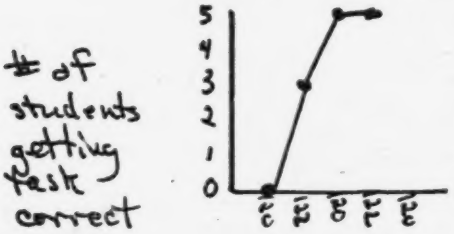
Group 21



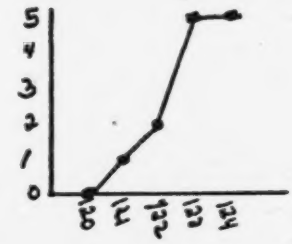
Group 22



Group 21a

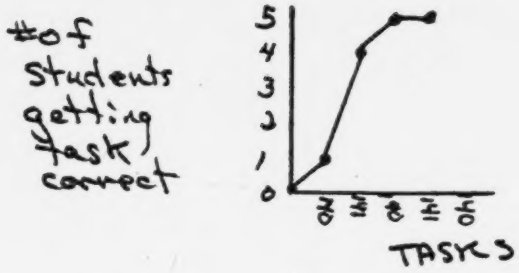


Group 22a

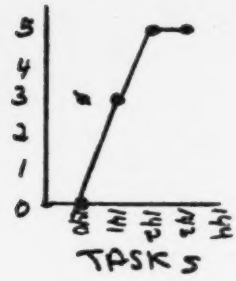


Learning Data

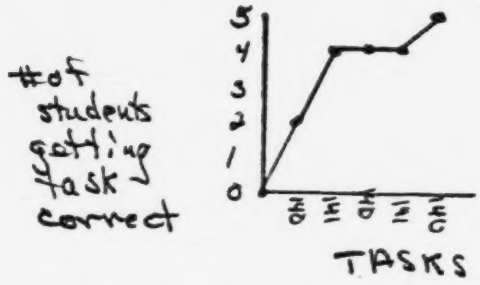
Group 25



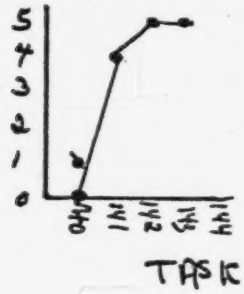
Group 26



Group 25a



Group 26a



Results of Third Set of Students

These students were very anxious to participate in the program and did not appear to need to be given a reward (the lollypop) for doing the work. They did not mind not receiving the paper from the terminal as previous students did because they never really knew it existed. The students just enjoyed coming into work on the terminal because it was something new and different.

All of the students were successful in completeing the program and although these students were slower on the average than previous students they did very similar work.

One student got two correct on Group 13c as was expected of him but the research assistant believes he memorized the examples and did not really understand the group although this did not appear to impede his completion of the program.**(see attached sheet on Paul)

A difference in the average amount of time for the different sets of groups was apparent with this set of students as was apparent with the previous set.

Strong Feedback - Repetition of 2 - 58.4 minutes
Weak Feedback - Repetition of 2 - 68.4 minutes
Strong Feedback - Repetition of 5 - 72.9 minutes
Weak Feedback - Repetition of 5 - 75 minutes

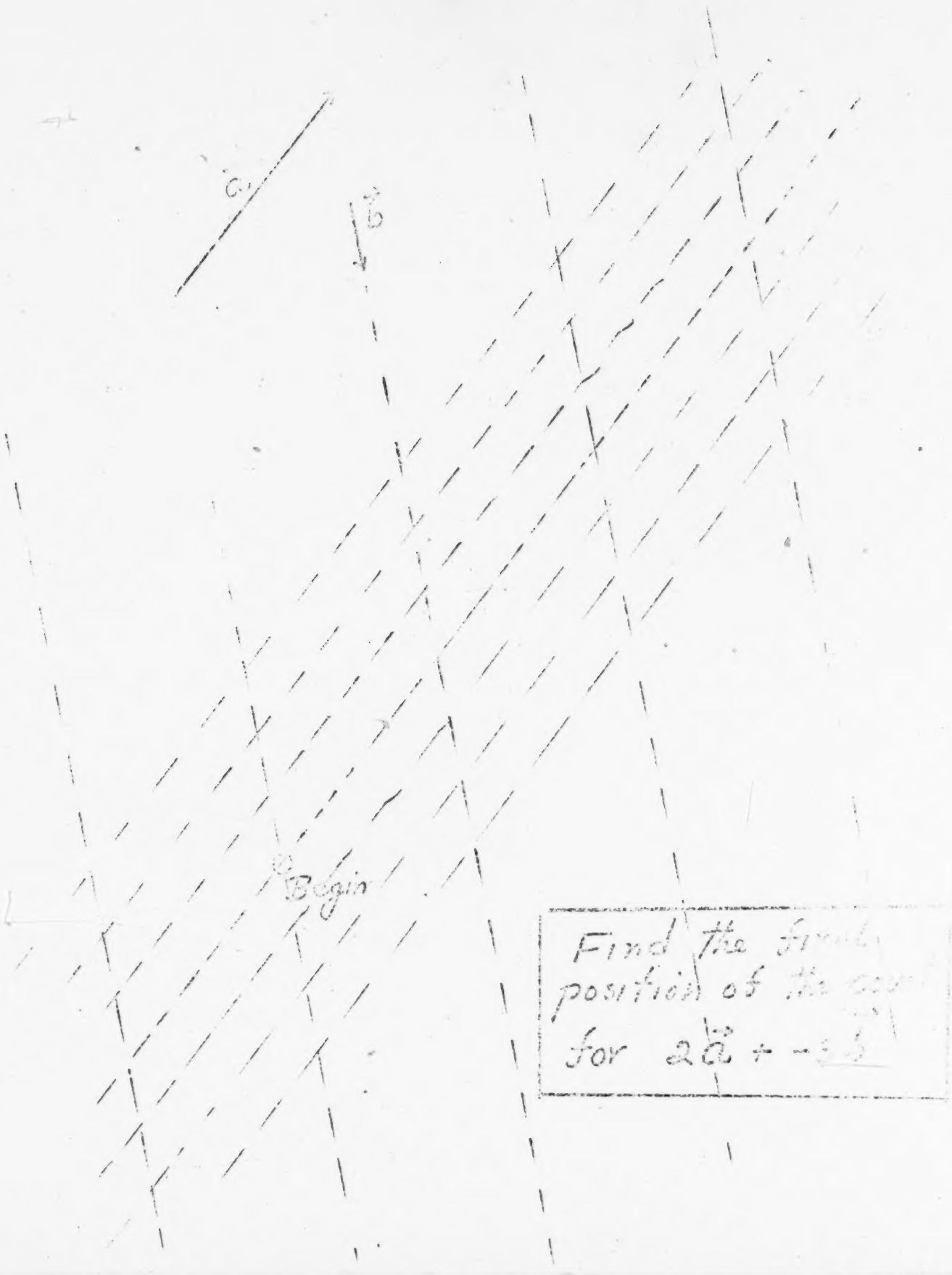
Although the difference is not as clear as in the previous group of students, it still took a longer period of time for the weak feedback as compared to the strong feedback to complete the program.

There were no problems with the students in regards to their behavior working with the research assistant either at the terminal or during testing.

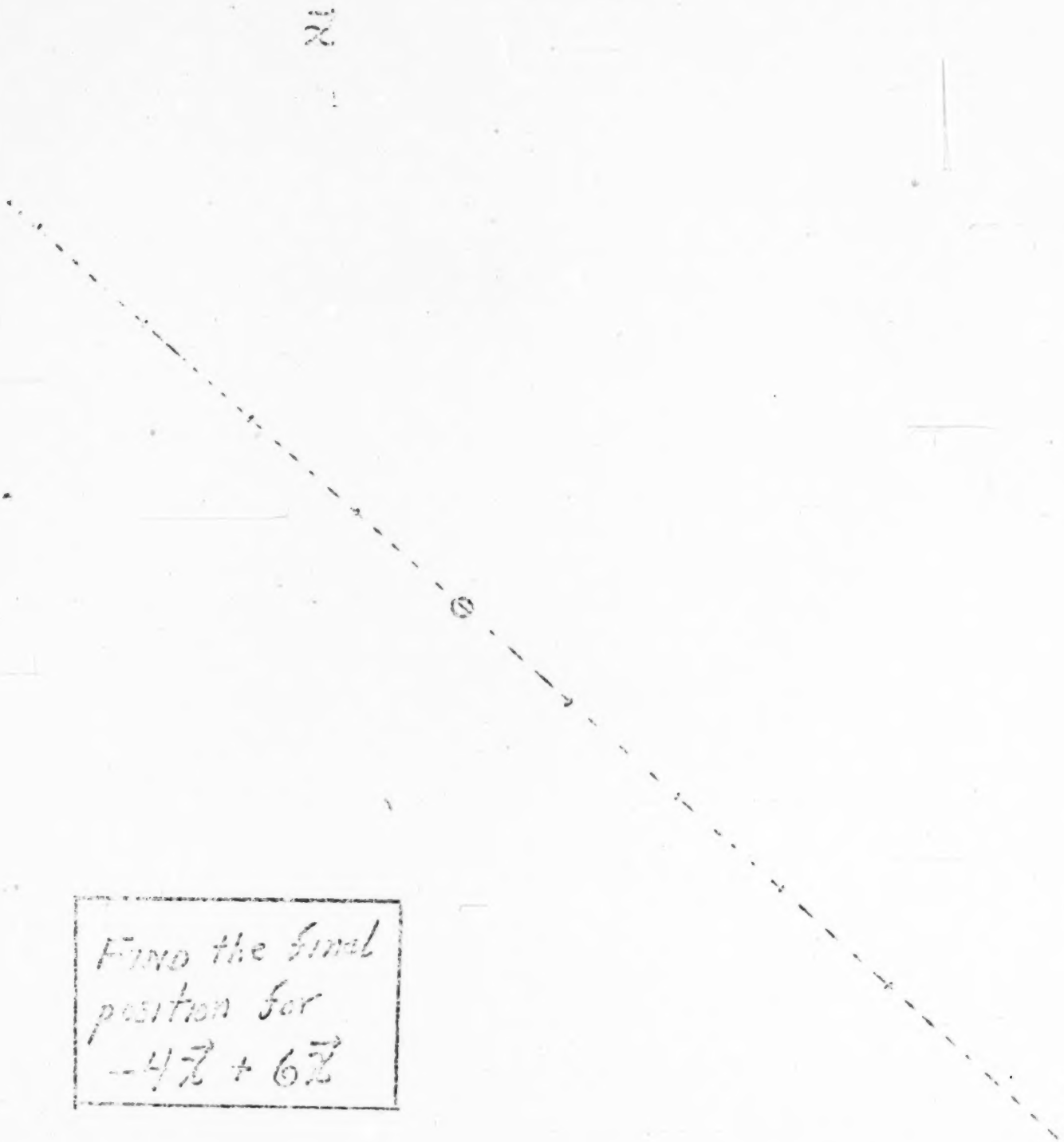
TO STUDENTS WHO WERE IN FOURTH, FIFTH, OR SIXTH GRADES LAST YEAR

Last spring Miss Perkins and I did some teaching of mathematics using a computer terminal: not all of you participated in this, but many of you did. This fall we need to find out whether you remember any of that material, and we would like to compare what those of you who participated can do with what those who didn't can do on the same problems. These will only take a few minutes, and they will not have anything to do with your grades or what the teacher thinks you know about arithmetic. Would you help us out, therefore, by giving us a few minutes of your time to try these problems? If you haven't any idea at all what the answer is then take a guess. On the first two pages, the answer is a point on the page, that is, you make a heavy, visible point to represent the final position of a dot, the initial (beginning) position is shown. On the last two pages, the answers are numbers, some with minus signs in front of them and some without. We want to thank you in advance for helping us: if you want to know what the answers are, you might discuss them with your friends who took part last spring, and then if there is any doubt, I'll be glad to furnish the correct answers.

Daniel Smith
Professor of Education


a
b
Begin
Find the final position of the car for 2a + -5

No. 3



Find the final position for $-4\vec{z} + 6\vec{z}$

No. 3

Fill in the blank

$5\vec{a} + -7\vec{a} = \_\_\ \vec{a}$

Give answers for these:

Sample: $5 + 3 = 8$

(a) $-2 + 7 =$ ____

(b) $-4 + 3 =$ ____

(c) $-6 + -2 =$ ____

REPORT ON COMPUTER PROGRAMING PROCEDURES

The first of a series of changes were made to the program "Datcol." After a few minor changes in instructions a copy of "Datcol" was made; called "D Copy". This was done so that if a programing error was made, the original could still be used until the error was located.

Changes were then continued. Changes were aimed at making the program run more rapidly for the user. Changes such as the advisor and student numbers only being asked once and instructions being given only when requested and an automatic fill-in of answers to finish a group when an advisor thought it wise to do so. The written text was adjusted to fit on a 32 character-wide TV screen.

A need for two identical programs occurred because it was decided to run more than one student at a time. The complications this causes requires some explanation:

Whenever a program is used, it is really a copy of one which is kept in "save storage" in the computer. Therefore hundreds of people could use the same program because each of those would be a copy of the one in "save storage." Unfortunately the IBM computer does not do the same for data files and it will allow a data file to be used by one program copy at a time.

The problem was, that "D Copy" and "Datcol" used 3 data files (the same 3, since one was a form of the other). One file kept the results, while another kept group and task numbers, and the third was used as a dump file (i.e. a file must be used to restore information to a file that is to be written on. This is because the writing process erases all previous stored information).

I wrote a program to copy information from one file to a new one but an error on my part caused the file that held the group and task numbers to be damaged. I decided to re-make the program at this point so that this file

wasn't needed. And since I was going to make this change I also decided to change the program language from FORTRAN to BASIC.

The advantages from this decision are many, the major ones include.

1). BASIC allows free format of characters when answering a question.

2). Two files were used instead of 3 (less cost of storage and a faster running program).

3). BASIC is a faster running system than FORTRAN; the computer time used by "Datcol" and "D Copy" were running from 13 to 19 seconds per student while the new programs, called "A," "B", and "C" would run from 1 to 3 second per student. A savings of about $1.50 per student.

VECTOR-REPETITION PROJECT

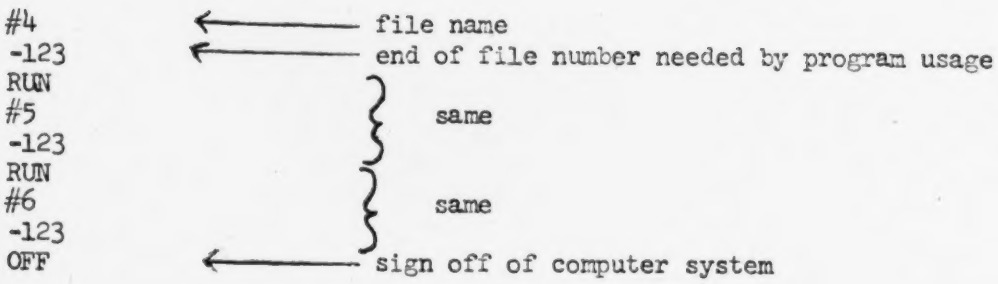
The following programs are used in the project in interaction with the student.

Program name	matching "dumpfile"	matching "record file"
A	ALPHA	#4
B	BETA	#5
C	GAMMA	#6

(that is: that a student using program "A" will automatically use Alpha as the "dump file" and his results will be recorded on file "#4").

The other four programs are run by a tape which controls the reporting of data from files #4, #5, and #6. The tape runs on the TAPE ALL COMMAND which allows all functions and answers to questions, to be placed on the tape before hand. The tape runs without supervision except for one place where it rings the return bell to call for the tape punch to be turned off. The last command on the tape signs off the computer. The list of commands on the tape follows.

TAPE ALL	← instructs computer to run tape control
RUN MAREDATA	← program to form data statements, punched on tape
#4	← file used
RUN	
#5	same
RUN	
#6	same
RUN BELL	← 1 minute ring of bell signal end of taping.
RUN READFILE	← makes chart of data
#4	← file used
RUN	
#5	same
RUN	
#6	same
PUR #4	
PUR #5	
PUR #6	files are purged
PUR ALPHA	
PUR BETA	
PUR GAMMA	
FILE #4,100	
FILE #5,100	files are reformed, the number 100 menas that
FILE #6,100	they can be used to store up to 100 file units.
FILE ALPHA, 100	1 file unit = 800 numbers
FILE BETA, 100	
FILE GAMMA, 100	
RUN STARTFIL	← program to set record file for future use



The exact function of the other four programs are:

MAREDATA: reads a data file and prints numbers in the form of data statements with line numbers. The tape punch makes paper tapes of the data lines. The format is such that the tape can be entered into the computer at anytime; various columns can be selectively read for staticial analysis. Each data line has eight numbers that correspond to "Readfile."

READFILE: reads a data file and prints it out in chart form. The chart has eight columns. They are from left to right: Advisor number, student number, Group number, Task number, Score, Record (the number of groups to be entered on that file), R1 and R2 (these are counters that have no use assigned to them). The data has the same pattern of information as "Datcol" had.

STARTFIL: initializes each record keeping file with the number -123. The number is uded by program A, B, and C, to note the end of the files records.

Bell: rings the return bell 600 times as a signal to turn off the tape punch. (1 minute at 10 rings per second).

A change made the week of June 2nd, makes the program reset and store data after each group is done, this way if the computer shuts down the most that is lost is one group. The cost is about one second of computer time more per student.

```
WIDTH 196
READY

LOAS A
READY

LIST

A            10:46   TUESDAY, MAY 30, 1972

0 REM FILES ARE RUN THROUGH A PROGRAM CALLED: STARTFIL
1 REM TO SET THE FIRST DATA ENTRY AT -123
2 REM THIS IS DONE TO THE FILE ONLY BEFORE IT IS RUN FOR THE 1ST TIME
3 REM TO CHANGE A TASK: THE FIRST DATA LINE IS GROUP 99, ALL FOLLOWING
4 REM ARE THE GROUPS ONE PER LINE, & COUNTING IN ORDER: GROUP 1 TO LAST

5 REM GROUP.  EACH PROGRAM MUST HAVE A DIFFERENT 'DUMP FILE' AND WHEN
6 REM MORE THAN ONE PROGRAM IS USED AT A TIME DIFFERENT FILES MUST BE
7 REM ENTERED WHEN THE QUESTION IS ASKED: FILE NAME?
8 REM FILES ARE READ BY THE PROGRAM:  READFILE
10 DIM A$(3)
11 DIM U(400)
12 DIM V(400)
13 DIM W(400)
14 DIM X(400)
15 DIM Y(400)
16 DIM Z(400)
17 DIM $(400)
18 DIM #(400)
19 DIM T(27,10)
20 FOR @=1 TO 3
30 READ A$(@)
40 NEXT @
50 DATA "RIGHT ON","QUITE CLOSE","TOO FAR OUT"
60 PRINT"ESCAPE CODE IS ANSWER: 4567"
66 Q3=0
70 PRINT
80 PRINT
90 PRINT"FILE NAME";
92 INPUT F$
98 MAT READ T
99 DATA 1,2,3,4,5,6,7,8,9,0
101 DATA 10,11,10,11,10,11,10,11,10,11
102 DATA 10,11,12,13,14,10,11,12,13,14
103 DATA 20,21,20,21,20,21,20,21,20,21
104 DATA 20,21,22,23,24,20,21,22,23,24
105 DATA 30,31,30,31,30,31,30,31,30,31
106 DATA 30,31,32,33,34,30,31,32,33,34
107 DATA 40,41,42,43,44,45,46,47,48,49
108 DATA 40,41,40,41,40,41,40,41,40,41
109 DATA 40,41,42,43,44,40,41,42,43,44
110 DATA 50,51,52,53,54,55,56,57,58,59
111 DATA 60,61,62,63,64,65,66,67,68,69
112 DATA 70,71,72,73,74,75,76,77,78,79
113 DATA 80,81,82,83,84,85,86,87,88,89
114 DATA 90,92,90,92,90,92,90,92,90,92
```

```
117 DATA 100,101,102,103,104,100,101,102,103,104
118 DATA 110,112,110,112,110,112,110,112,110,112
119 DATA 110,111,112,113,114,110,111,112,113,114
120 DATA 120,121,122,123,124,125,126,127,125,129
121 DATA 120,122,120,122,120,122,120,122,120,122
122 DATA 120,121,122,123,124,120,121,122,123,124
123 DATA 130,131,132,133,134,135,136,137,138,139
124 DATA 140,141,142,143,144,145,146,147,148,149
125 DATA 140,141,140,141,140,141,140,141,140,141
126 DATA 140,141,142,143,144,140,141,142,143,144
128 OPEN 1,F$,INPUT
129 OPEN 2,'ALPHA',OUTPUT
130 FOR 0=1 TO 2000
140 GET 1:H1,H2,H3,H4,H5,H6,H7,H8
141 REM A=ADVISOR,S1=STUDENT,G=GROUP,T=TASK,S=SCORE,N1=RECORD # IN THE
142 REM FILE BEING USED,Q1 & Q2 ARE COUNTERS OF LITTLE VALUE,Q3=THE
143 REM COUNTER OF TASKS FOR THE STORAGE OF RESULTS.
145 IF H1=-123 THEN 180
147 A=H1
148 S1=H2
149 G=H3
150 T=H4
151 S=H5
152 N1=H6
153 Q1=H7
154 Q2=H8
160 PUT 2:A,S1,G,T,S,N1,Q1,Q2
165 N3=0
170 NEXT 0
180 CLOSE 1,2
181 N1=N1+1
184 IF $$='NO' GOTO 220
187 Q2=0
190 PRINT
200 PRINT"ADVISOR# (COMMA) STUDENT#";
210 INPUT A,S1
220 PRINT
230 PRINT"FILE ";F$;" RECORD";N1
240 PRINT
250 PRINT"WHAT GROUP WOULD YOU LIKE";
260 INPUT G
270 PRINT
280 IF G=99 GOTO 1208
290 IF G<=0 GOTO 250
300 IF G>=27 GOTO 250
1208 PRINT
1209 Q1=0
1210 PRINT"DO YOU WANT INSTRUCTIONS";
1220 INPUT $$
1230 PRINT
1240 IF $$='NO' GOTO 3000
1250 IF $$<>'YES' GOTO 1210
1260 GOTO 1500,1500,1500 ON G-23
1270 IF G=99 GOTO 2400
1280 IF G>=10 GOTO 2100
1500 PRINT
1510 PRINT" EACH PICTURE IS A PROBLEM."
1520 PRINT"PLEASE POINT TO A PLACE ON THE"
1530 PRINT"PAGE WHICH IN YOUR OPINION IS"
1540 PRINT"THE CORRECT ANSWER. THE COMPUTER"
1550 PRINT"WILL TELL YOU WHETHER YOU WERE:"
1560 PRINT"RIGHT ON THE CORRECT ANSWER,"
1570 PRINT"CLOSE TO IT, OR"
1580 PRINT"TOO FAR OUT"
1590 PRINT
```

```
1610 REMARK
1620 GOTO 3000
2100 PRINT
2110 PRINT"THE COMPUTER WILL ASK IF YOU ARE"
2120 PRINT"READY. AFTER ANSWERING: YES"
2130 PRINT"TYPE THE CORRECT ANSWER THAT"
2140 PRINT"BEST DESCRIBES THE PROBLEM. THE"
2150 PRINT"COMPUTER WILL TELL YOU WHETHER"
2160 PRINT"YOU WERE RIGHT ON"
2170 PRINT"QUITE CLOSE, OR"
2180 PRINT"TOO FAR OUT."
2190 REM(THE COMPUTER WILL THEN TYPE THE CORRECT ANSWER)
2200 REM
2210 REM
2220 PRINT"-->ENTER ALL POSSIBLE WAYS<--"
2230 PRINT
2240 GOTO 3000
2400 PRINT
2410 PRINT"  FOR PROBLEMS 1, 2, 3."
2420 PRINT"PLEASE POINT TO WHAT YOU THINK"
2430 PRINT"IS THE CORRECT ANSWER.  FOR"
2440 PRINT"ALL THE REST, JUST TYPE THE"
2450 PRINT"ANSWER YOU THINK IS BEST"
2460 PRINT"AFTER THE COMPUTER ASKS: READY"
2470 PRINT"AND YOU HAVE TYPED: YES"
2480 PRINT
3000 REM   END OF INSTRUCTIONS  QUESTIONS FOLLOW
3050 N=10
3100 FOR I=1 TO N
3140 Z1=0
3280 G2=I
3290 GOSUB 50000
3300 PRINT T;"READY";
3302 Q1=Q1+1
3304 INPUT S$
3305 IF S$<>'YES' GOTO 3300
3306 GOTO 3315,3315,3315 ON G-23
3308 IF G<10 GOTO 3315
3310 IF T<4 GOTO 3315
3312 PRINT"WHAT DO YOU THINK THE ANSWER IS"
3314 INPUT @$
3315 PRINT
3340 REM
3350 PRINT"ANSWER";
3360 INPUT S
3365 Q2=Q2+1
3370 IF S=4567 GOTO 3540
3390 GOTO 3700,3440,3440 ON S
3400 GOTO 3350
3440 IF G<10 GOTO 3700
3450 GOTO 3700,3700,3700 ON G-23
3460 IF T<=3 GOTO 3700
3470 PRINT
3480 PRINT A$(S)
3490 PRINT
3500 PRINT"WHAT ANSWERS ARE RIGHT ON"
3510 INPUT @$
3519 Z1=1
3530 GOTO 3700
3535 REM   END OF QUESTIONS, AUTO. FILL IN FOLLOWS
3540 PRINT
3550 PRINT"AUTOMATIC FILL IN"
3560 PRINT
3570 S=4
3580 GOSUB 40000
```

```
3600 S=4
3610 Q1=Q1+1
3620 Q2=Q2+1
3622 G2=0
3624 GOSUB 50000
3630 GOSUB 40000
3640 NEXT 0
3650 GOTO 3800
3700 GOSUB 40000
3704 PRINT
3707 PRINT
3708 IF Z1=1 GOTO 3750
3710 PRINT A$(S)
3720 PRINT
3750 NEXT I
3760 REM   END OF LOOP THAT GIVES THE GROUP!
3800 PRINT
3810 PRINT"ARE YOU DONE WITH EVERYTHING"
3820 INPUT S$
3830 IF S$='YES' GOTO 4900
3840 IF S$='NO' GOTO 3900
3850 PRINT"YES OR NO";
3860 GOTO 3820
3900 PRINT
3910 REM   BY FILLING THE FILE AFTER EACH GROUP, NO MORE THAN ONE GROUP

3920 REM CAN BE LOST BY A COMPUTER SHUT DOWN.
4900 OPEN 3,FS,OUTPUT
4910 OPEN 4,'ALPHA',INPUT
5000 FOR 0=1 TO N3
5010 GET 4:A,S1,G,T,S,N2,Q1,Q2
5020 PUT 3:A,S1,G,T,S,N2,Q1,Q2
5030 NEXT 0
5100 FOR 0=1 TO Q3
5110 PUT 3:U(0)
5120 PUT 3:V(0)
5130 PUT 3:W(0)
5140 PUT 3:X(0)
5150 PUT 3:Y(0)
5160 PUT 3:Z(0)
5170 PUT 3:$(0)
5180 PUT 3:#(0)
5190 NEXT 0
5200 A,S1,G,T,S,N2,Q1,Q2=-123
5210 PUT 3:A,S1,G,T,S,N2,Q1,Q2
5250 CLOSE 3,4
5300 IF S$='YES' GOTO 39999
5320 Q3=0
5340 GOTO 128
39999 STOP  SUBPROGRAMS FOLLOW
40000 Q3=Q3+1
40100 U(Q3)=A
40120 V(Q3)=S1
40130 W(Q3)=G
40140 X(Q3)=T(G1,G2)
40150 Y(Q3)=S
40160 Z(Q3)=N1
40170 $(Q3)=Q1
40180 #(Q3)=Q2
41000 RETURN AFTER EACH TASK
50000 REM
50100 G1=1
50200 IF G=99 GOTO 50400
50300 G1=G+1
50400 T=T(G1,G2)
```

```
LOAD B
READY

LIST

B              10:59   TUESDAY, MAY 30, 1972

 0 REM FILES ARE RUN THROUGH A PROGRAM CALLED: STARTFIL
 1 REM TO SET THE FIRST DATA ENTRY AT -123
 2 REM THIS IS DONE TO THE FILE ONLY BEFORE IT IS RUN FOR THE 1ST TIME
 3 REM TO CHANGE A TASK: THE FIRST DATA LINE IS GROUP 99, ALL FOLLOWING
 4 REM ARE THE GROUPS ONE PER LINE, & COUNTING IN ORDER: GROUP 1 TO LAST

 5 REM GROUP.  EACH PROGRAM MUST HAVE A DIFFERENT 'DUMP FILE' AND WHEN
 6 REM MORE THAN ONE PROGRAM IS USED AT A TIME DIFFERENT FILES MUST BE
 7 REM ENTERED W HEN THE QUESTION IS ASKED: FILE NAME?
 8 REM FILES ARE READ BY THE PROGRAM:  READFILE
 10 DIM A$(3)
 11 DIM U(400)
 12 DIM V(400)
 13 DIM W(400)
 14 DIM X(400)
 15 DIM Y(400)
 16 DIM Z(400)
 17 DIM S(400)
 18 DIM #(400)
 19 DIM T(27,10)
 20 FOR @=1 TO 3
 30 READ A$(@)
 40 NEXT @
 50 DATA "RIGHT ON","QUITE CLOSE","TOO FAR OUT"
 60 PRINT"ESCAPE CODE IS ANSWER: 4567"
 66 Q3=0
 70 PRINT
 80 PRINT
 90 PRINT"FILE NAME";
 92 INPUT F$
 98 MAT READ T
 99 DATA 1,2,3,4,5,6,7,8,9,0
101 DATA 10,11,10,11,10,11,10,11,10,11
102 DATA 10,11,12,13,14,10,11,12,13,14
103 DATA 20,21,20,21,20,21,20,21,20,21
104 DATA 20,21,22,23,24,20,21,22,23,24
105 DATA 30,31,30,31,30,31,30,31,30,31
106 DATA 30,31,32,33,34,30,31,32,33,34
107 DATA 40,41,42,43,44,45,46,47,48,49
108 DATA 40,41,40,41,40,41,40,41,40,41
109 DATA 40,41,42,43,44,40,41,42,43,44
110 DATA 50,51,52,53,54,55,56,57,58,59
111 DATA 60,61,62,63,64,65,66,67,68,69
112 DATA 70,71,72,73,74,75,76,77,78,79
113 DATA 80,81,82,83,84,85,86,87,88,89
114 DATA 90,92,90,92,90,92,90,92,90,92
115 DATA 90,91,92,93,94,90,91,92,93,94
116 DATA 100,101,100,101,100,101,100,101,100,101
117 DATA 100,101,102,103,104,100,101,102,103,104
118 DATA 110,112,110,112,110,112,110,112,110,112
119 DATA 110,111,112,113,114,110,111,112,113,114
120 DATA 120,121,122,123,124,125,126,127,128,129
121 DATA 120,122,120,122,120,122,120,122,120,122
122 DATA 120,121,122,123,124,120,121,122,123,124
123 DATA 130, 131,132,133,134,135,136,137,138,139
```

```
124 DATA 140,141,142,143,144,145,146,147,148,149
125 DATA 140,141,140,141,140,141,140,141,140,141
126 DATA 140, 141,142,143,144,140,141,142,143,144
128 OPEN 1,FS,INPUT
129 OPEN 2,'BETA',OUTPUT
130 FOR @=1 TO 2000
140 GET 1:H1,H2,H3,H4,H5,H6,H7,H8
141 REM A=ADVISOR,S1=STUDENT,G=GROUP,T=TASK,S=SCORE,N1=RECORD # IN THE
142 REM FILE BEING USED,Q1 & Q2 ARE COUNTERS OF LITTLE VALUE,Q3=THE
143 REM COUNTER OF TASKS FOR THE STORAGE OF RESULTS.
145 IF H1=-123 THEN 180
147 A=H1
148 S1=H2
149 G=H3
150 T=H4
151 S=H5
152 N1=H6
153 Q1=H7
154 Q2=H8
160 PUT 2:A,S1,G,T,S,N1,Q1,Q2
165 N3=@
170 NEXT @
180 CLOSE 1,2
181 N1=N1+1
184 IF $$='NO' GOTO 220
187 Q2=0
190 PRINT
200 PRINT"ADV ISOR# (COMMA) STUDENT#";
210 INPUT A,S1
220 PRINT
230 PRINT"FILE ";FS;" RECORD";N1
240 PRINT
250 PRINT"W HAT GROUP WOULD YOU LIKE";
260 INPUT G
270 PRINT
280 IF G=99 GOTO 1208
290 IF G<=0 GOTO 250
300 IF G>=27 GOTO 250
1208 PRINT
1209 Q1=0
1210 PRINT"DO YOU WANT INSTRUCTIONS";
1220 INPUT $$
1230 PRINT
1240 IF $$='NO' GOTO 3000
1250 IF $$<>'YES' GOTO 1210
1260 GOTO 1500,1500,1500 ON G-23
1270 IF G=99 GOTO 2400
1280 IF G>=10 GOTO 2100
1500 PRINT
1510 PRINT" EACH PICTURE IS A PROBLEM."
1520 PRINT"PLEASE POINT TO A PLACE ON THE"
1530 PRINT"PAGE WHICH IN YOUR OPINION IS"
1540 PRINT"THE CORRECT ANSWER. THE COMPUTER"
1550 PRINT"WILL TELL YOU WHETHER YOU WERE:"
1560 PRINT"RIGHT ON THE CORRECT ANSWER,"
1570 PRINT"CLOSE TO IT, OR"
1580 PRINT"TOO FAR OUT"
1590 PRINT
1600 REM (THE COMPUTER WILL SOME DAY TELL THE CORRECT ANSWER)
1610 REMARK
1620 GOTO 3000
2100 PRINT
2110 PRINT"THE COMPUTER WILL ASK IF YOU ARE"
2120 PRINT"READY. AFTER ANSWERING: YES"
2130 PRINT"TYPE THE CORRECT ANSWER THAT"
```

```
2150 PRINT"COMPUTER WILL TELL YOU WHETHER"
2160 PRINT"YOU WERE RIGHT ON"
2170 PRINT"QUITE CLOSE, OR"
2180 PRINT"TOO FAR OUT."
2190 REM(THE COMPUTER WILL THEN TYPE THE CORRECT ANSWER)
2200 REM
2210 REM
2220 PRINT"-->ENTER ALL POSSIBLE WAYS<--"
2230 PRINT
2240 GOTO 3000
2400 PRINT
2410 PRINT"  FOR PROBLEMS 1, 2, 3."
2420 PRINT"PLEASE POINT TO WHAT YOU THINK"
2430 PRINT"IS THE CORRECT ANSWER.  FOR"
2440 PRINT"ALL THE REST, JUST TYPE THE"
2450 PRINT"ANSW ER YOU THINK IS BEST"
2460 PRINT"AFTER THE COMPUTER ASKS: READY"
2470 PRINT"AN D YOU HAVE TYPED: YES"
2480 PRINT
3000 REM   END OF INSTRUCTIONS  QUESTIONS FOLLOW
3050 N=10
3100 FOR I=1 TO N
3140 Z1=0
3280 G2=I
3290 GOSUB 50000
3300 PRINT T;"READY";
3302 Q1=Q1+1
3304 INPUT $S
3305 IF S$<>'YES' GOTO 3300
3306 GOTO 3315,3315,3315 ON G-23
3308 IF G<10 GOTO 3315
3310 IF T<4 GOTO 3315
3312 PRINT"WHAT DO YOU THINK THE ANSWER IS"
3314 INPUT @$
3315 PRINT
3340 REM
3350 PRINT"ANSWER";
3360 INPUT S
3365 Q2=Q2+1
3370 IF S=4567 GOTO 3540
3390 GOTO 3700,3440,3440 ON S
3400 GOTO 3350
3440 IF G<10 GOTO 3700
3450 GOTO 3700,3700,3700 ON G-23
3460 IF T<=3 GOTO 3700
3470 PRINT
3480 PRINT A$(S)
3490 PRINT
3500 PRINT"WHAT ANSWERS ARE RIGHT ON"
3510 INPUT @$
3519 Z1=1
3530 GOTO 3700
3535 REM   END OF QUESTIONS, AUTO. FILL IN FOLLOWS
3540 PRINT
3550 PRINT"AUTOMATIC FILL IN"
3560 PRINT
3570 S=4
3580 GOSUB 40000
3590 FOR @=I+1 TO N
3600 S=4
3610 Q1=Q1+1
3620 Q2=Q2+1
3622 G2=@
3624 GOSUB 50000
3630 GOSUB 40000
```

```
3640 NEXT @
3650 GOTO 3800
3700 GOSUB 40000
3704 PRINT
3707 PRINT
3708 IF Z1=1 GOTO 3750
3710 PRINT A$(S)
3720 PRINT
3750 NEXT I
3760 REM   END OF LOOP THAT GIVES THE GROUP!
3800 PRINT
3810 PRINT"ARE YOU DONE WITH EVERYTHING"
3820 INPUT $$
3830 IF $$='YES' GOTO 4900
3840 IF $$='NO' GOTO 3900
3850 PRINT"YES OR NO";
3860 GOTO 3820
3900 PRINT
3910 REM   BY FILLING THE FILE AFTER EACH GROUP, NO MORE THAN ONE GROUP
3920 REM CAN BE LOST BY A COMPUTER SHUT DOWN.
4900 OPEN 3,FS,OUTPUT
4910 OPEN 4,'BETA',INPUT
5000 FOR @=1 TO N3
5010 GET 4:A,S1,G,T,S,N2,Q1,Q2
5020 PUT 3:A,S1,G,T,S,N2,Q1,Q2
5030 NEXT @
5100 FOR @=1 TO Q3
5110 PUT 3:U(@)
5120 PUT 3:V(@)
5130 PUT 3:W(@)
5140 PUT 3:X(@)
5150 PUT 3:Y(@)
5160 PUT 3:Z(@)
5170 PUT 3:$(@)
5180 PUT 3:#(@)
5190 NEXT @
5200 A,S1,G,T,S,N2,Q1,Q2=-123
5210 PUT 3:A,S1,G,T,S,N2,Q1,Q2
5250 CLOSE 3,4
5300 IF $$='YES' GOTO 39999
5320 Q3=0
5340 GOTO 128
39999 STOP  S UBPROGRAMS FOLLOW
40000 Q3=Q3+1
40100 U(N3)=A
40120 V(Q3)=S1
40130 W(Q3)=G
40140 X(Q3)=T(G1,G2)
40150 Y(Q3)=S
40160 Z(Q3)=N1
40170 $(Q3)=Q1
40180 #(Q3)=Q2
41000 RETURN AFTER EACH TASK
50000 REM
50100 G1=1
50200 IF G=99 GOTO 50400
50300 G1=G+1
50400 T=T(G1,G2)
50500 RETURN AFTER SETTING UP THE RIGHT TASK NUMBER
99999 END
```

```
LOAD C
READY

@LIST
WHAT?
LIST

C            11:13   TUESDAY, MAY 30, 1972

 0 REM FILES ARE RUN THROUGH A PROGRAM CALLED: STARTFIL
 1 REM TO SET THE FIRST DATA ENTRY AT -123
 2 REM THIS IS DONE TO THE FILE ONLY BEFORE IT IS RUN FOR THE 1ST TIME
 3 REM TO CHANGE A TASK: THE FIRST DATA LINE IS GROUP 99, ALL FOLLOWING
 4 REM ARE THE GROUPS ONE PER LINE, & COUNTING IN ORDER: GROUP 1 TO LAST

 5 REM GROUP.  EACH PROGRAM MUST HAVE A DIFFERENT 'DUMP FILE' AND WHEN
 6 REM MORE THAN ONE PROGRAM IS USED AT A TIME DIFFERENT FILES MUST BE
 7 REM ENTERED WHEN THE QUESTION IS ASKED: FILE NAME?
 8 REM FILES ARE READ BY THE PROGRAM:  READFILE
 10 DIM A$(3)
 11 DIM U(400)
 12 DIM V(400)
 13 DIM W(400)
 14 DIM X(400)
 15 DIM Y(400)
 16 DIM Z(400)
 17 DIM $(400)
 18 DIM #(400)
 19 DIM T(27,10)
 20 FOR 0=1 TO 3
 30 READ A$(0)
 40 NEXT 0
 50 DATA "RIGHT ON","QUITE CLOSE","TOO FAR OUT"
 60 PRINT"ESCAPE CODE IS ANSWER: 4567"
 66 Q3=0
 70 PRINT
 80 PRINT
 90 PRINT"FILE NAME";
 92 INPUT F$
 98 MAT READ T
 99 DATA 1,2,3,4,5,6,7,8,9,0
 101 DATA 10,11,10,11,10,11,10,11,10,11
 102 DATA 10,11,12,13,14,10,11,12,13,14
 103 DATA 20,21,20,21,20,21,20,21,20,21
 104 DATA 20,21,22,23,24,20,21,22,23,24
 105 DATA 30,31,30,31,30,31,30,31,30,31
 106 DATA 30,31,32,33,34,30,31,32,33,34
 107 DATA 40,41,42,43,44,45,46,47,48,49
 108 DATA 40,41,40,41,40,41,40,41,40,41
 109 DATA 40,41,42,43,44,40,41,42,43,44
 110 DATA 50,51,52,53,54,55,56,57,58,59
 111 DATA 60,61,62,63,64,65,66,67,68,69
 112 DATA 70,71,72,73,74,75,76,77,78,79
 113 DATA 80,81,82,83,84,85,86,87,88,89
 114 DATA 90,92,90,92,90,92,90,92,90,92
 115 DATA 90,91,92,93,94,90,91,92,93,94
 116 DATA 100,101,100,101,100,101,100,101,100,101
 117 DATA 100,101,102,103,104,100,101,102,103,104
 118 DATA 110,112,110,112,110,112,110,112,110,112
 119 DATA 110,111,112,113,114,110,111,112,113,114
 120 DATA 120,121,122,123,124,125,126,127,128,129
 121 DATA 120,122,120,122,120,122,120,122,120,122
 122 DATA 120,121,122,123,124,120,121,122,123,124
```

```
124 DATA 140,141,142,143,144,145,146,147,148,149
125 DATA 140,141,140,141,140,141,140,141,140,141
126 DATA 140,141,142,143,144,140,141,142,143,144
128 OPEN 1,F$,INPUT
129 OPEN 2,'GAMMA',OUTPUT
130 FOR 9=1 TO 2000
140 GET 1:H1,H2,H3,H4,H5,H6,H7,H8
141 REM A=ADVISOR,S1=STUDENT,G=GROUP,T=TASK,S=SCORE,N1=RECORD # IN THE
142 REM FILE BEING USED,Q1 & Q2 ARE COUNTERS OF LITTLE VALUE,Q3=THE
143 REM COUNTER OF TASKS FOR THE STORAGE OF RESULTS.
145 IF H1=-123 THEN 180
147 A=H1
148 S1=H2
149 G=H3
150 T=H4
151 S=H5
152 N1=H6
153 Q1=H7
154 Q2=H8
160 PUT 2:A,S1,G,T,S,N1,Q1,Q2
165 N3=9
170 NEXT 9
180 CLOSE 1,2
181 N1=N1+1
184 IF $$='NO' GOTO 220
187 Q2=0
190 PRINT
200 PRINT"ADVISOR# (COMMA) STUDENT#";
210 INPUT A,S1
220 PRINT
230 PRINT"FILE ";F$;" RECORD";N1
240 PRINT
250 PRINT"W HAT GROUP WOULD YOU LIKE";
260 INPUT G
270 PRINT
280 IF G=99 GOTO 1208
290 IF G<=0 GOTO 250
300 IF G>=27 GOTO 250
1208 PRINT
1209 Q1=0
1210 PRINT"DO YOU WANT INSTRUCTIONS";
1220 INPUT $$
1230 PRINT
1240 IF $$='NO' GOTO 3000
1250 IF $$<>'YES' GOTO 1210
1260 GOTO 1500,1500,1500 ON G-23
1270 IF G=99 GOTO 2400
1280 IF G>=10 GOTO 2100
1500 PRINT
1510 PRINT" EACH PICTURE IS A PROBLEM."
1520 PRINT"PLEASE POINT TO A PLACE ON THE"
1530 PRINT"PAGE W HICH IN YOUR OPINION IS"
1540 PRINT"THE CORRECT ANSWER. THE COMPUTER"
1550 PRINT"WILL TELL YOU WHETHER YOU WERE:"
1560 PRINT"RIGHT ON THE CORRECT ANSWER,"
1570 PRINT"CLOSE TO IT, OR"
1580 PRINT"T00 FAR OUT"
1590 PRINT
1600 REM (THE COMPUTER WILL SOME DAY TELL THE CORRECT ANSWER)
1610 REMARK
1620 GOTO 3000
2100 PRINT
2110 PRINT"THE COMPUTER WILL ASK IF YOU ARE"
2120 PRINT"READY. AFTER ANSWERING: YES"
2130 PRINT"TYPE THE CORRECT ANSWER THAT"
```

```
2150 PRINT"COMPUTER WILL TELL YOU WHETHER"
2160 PRINT"YOU WERE RIGHT ON"
2170 PRINT"QUITE CLOSE, OR"
2180 PRINT"T OO FAR OUT."
2190 REM(THE COMPUTER WILL THEN TYPE THE CORRECT ANSWER)
2200 REM
2210 REM
2220 PRINT"-->ENTER ALL POSSIBLE WAYS<--"
2230 PRINT
2240 GOTO 3000
2400 PRINT
2410 PRINT"  FOR PROBLEMS 1, 2, 3."
2420 PRINT"PLEASE POINT TO WHAT YOU THINK"
2430 PRINT"IS THE CORRECT ANSWER.  FOR"
2440 PRINT"ALL THE REST, JUST TYPE THE"
2450 PRINT"ANSWER YOU THINK IS BEST"
2460 PRINT"AFTER THE COMPUTER ASKS: READY"
2470 PRINT"AND YOU HAVE TYPED: YES"
2480 PRINT
3000 REM   END OF INSTRUCTIONS  QUESTIONS FOLLOW
3050 N=10
3100 FOR I=1 TO N
3140 Z1=0
3280 G2=I
3290 GOSUB 50000
3300 PRINT T;"READY";
3302 Q1=Q1+1
3304 INPUT S$
3305 IF S$<>'YES' GOTO 3300
3306 GOTO 3315,3315,3315 ON G-23
3308 IF G<10 GOTO 3315
3310 IF T<4 GOTO 3315
3312 PRINT"WHAT DO YOU THINK THE ANSWER IS"
3314 INPUT @$
3315 PRINT
3340 REM
3350 PRINT"ANSWER";
3360 INPUT S
3365 Q2=Q2+1
3370 IF S=4567 GOTO 3540
3390 GOTO 3700,3440,3440 ON S
3400 GOTO 3350
3440 IF G<10 GOTO 3700
3450 GOTO 3700,3700,3700 ON G-23
3460 IF T<= 3 GOTO 3700
3470 PRINT
3480 PRINT A$(S)
3490 PRINT
3500 PRINT"WHAT ANSWERS ARE RIGHT ON"
3510 INPUT @$
3519 Z1=1
3530 GOTO 3700
3535 REM   END OF QUESTIONS, AUTO. FILL IN FOLLOWS
3540 PRINT
3550 PRINT"AUTOMATIC FILL IN"
3560 PRINT
3570 S=4
3580 GOSUB 40000
3590 FOR @=I+1 TO N
3600 S=4
3610 Q1=Q1+1
3620 Q2=Q2+1
3622 G2=@
3624 GOSUB 50000
```

```
3630 GOSUB 40000
3640 NEXT @
3650 GOTO 3800
3700 GOSUB 40000
3704 PRINT
3707 PRINT
3706 IF Z1=1 GOTO 3750
3710 PRINT A$(S)
3720 PRINT
3750 NEXT I
3760 REM   END OF LOOP THAT GIVES THE GROUP!
3800 PRINT
3810 PRINT"ARE YOU DONE WITH EVERYTHING"
3820 INPUT $$
3830 IF $$='YES' GOTO 4900
3840 IF $$='NO' GOTO 3900
3850 PRINT"YES OR NO";
3860 GOTO 3820
3900 PRINT
3910 REM   BY FILLING THE FILE AFTER EACH GROUP, NO MORE THAN ONE GROUP
3920 REM CAN BE LOST BY A COMPUTER SHUT DOWN.
4900 OPEN 3,FS,OUTPUT
4910 OPEN 4,'GAMMA',INPUT
5000 FOR @=1 TO N3
5010 GET 4:A,S1,G,T,S,N2,Q1,Q2
5020 PUT 3:A,S1,G,T,S,N2,Q1,Q2
5030 NEXT @
5100 FOR @=1 TO Q3
5110 PUT 3:U(@)
5120 PUT 3:V(@)
5130 PUT 3:W(@)
5140 PUT 3:X(@)
5150 PUT 3:Y(@)
5160 PUT 3:Z(@)
5170 PUT 3:$(@)
5180 PUT 3:#(@)
5190 NEXT @
5200 A,S1,G,T,S,N2,Q1,Q2=-123
5210 PUT 3:A,S1,G,T,S,N2,Q1,Q2
5250 CLOSE 3,4
5300 IF $$= 'YES' GOTO 39999
5320 Q3=0
5340 GOTO 128
39999 STOP  SUBPROGRAMS FOLLOW
40000 Q3=Q3+1
40100 U(Q3)=A
40120 V(Q3)=S1
40130 W(Q3)=G
40140 X(Q3)=T(G1,G2)
40150 Y(Q3)=S
40160 Z(Q3)=N1
40170 $(Q3)=Q1
40180 #(Q3)=Q2
41000 RETURN AFTER EACH TASK
50000 REM
50100 G1=1
50200 IF G=99 GOTO 50400
50300 G1=G+1
50400 T=T(G1,G2)
50500 RETURN AFTER SETTING UP THE RIGHT TASK NUMBER
99999 END
```

REPORT ON SEARCH FOR INEXPENSIVE GRAPHIC CAPABILITIES

System using equipment from:

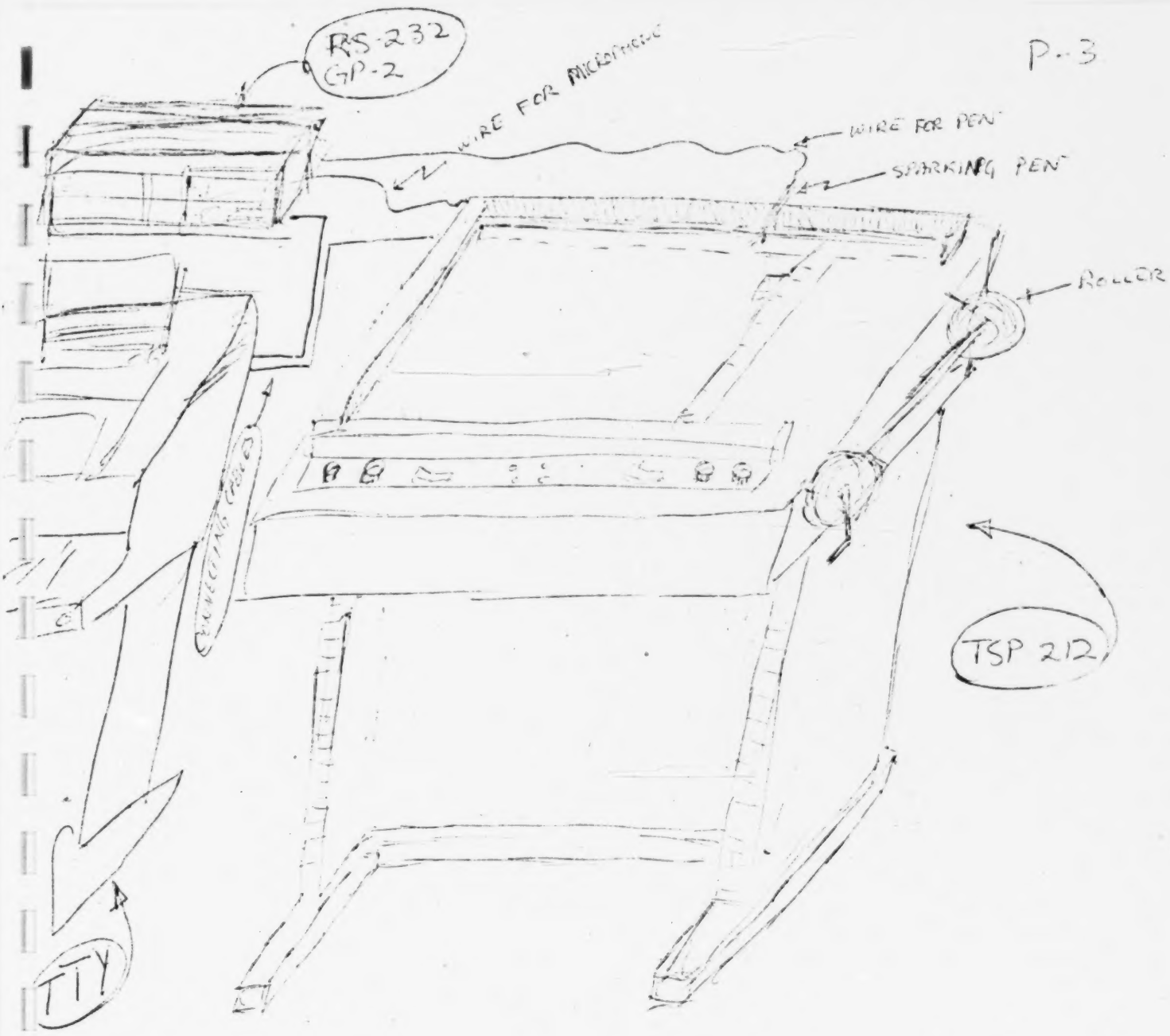
(DMA) Digital Marketing Associates
P.O. Box 309
SUDBURY, MASS 01776
617-890-7148
Contact: Ed King

(TSP) TSP CORP, TIME SHARE PERIPHERALS CORPORATION
MIRY BROOK RD.
DANBURY, CONN 06810
203-743-7624
CONTACT: EDWARD A. SCHAFER, JR (sales)
Contact: Michael P. Taylor (Engineering)

NOTE: Digital Marketing Associates does marketing for SAC, Science Accessories Corporation, a subsidiary of Amperex Electronic Corp., A North American Philips Company

UNIT	WHAT IT DOES	PRICE
TSP 212	PLOTTER ON TABLE, WITH INTERFACE BUILT IN, COMPLETE WITH CABLES TO TELETYPE, NO OTHER EQUIPMENT NEEDED NO SERVICE CONTRACT NEEDED NO MODIFICATION TO TIME SHARE SYSTEM. PROGRAMS FOR VARIOUS ROUTINES INCLUDED AT NO CHARGE.	$3300 (TSP)

UNIT	WHAT IT DOES	PRICE
GRAF/PEN (TM), LPD-11 GRAPHICS SYSTEM (ALSO CALLED VNOT) {WRITING TABLET} {BY DIGITAL EQUIPMENT CORPORATION}	PEN CONSISTS OF ~~STRIKING~~ INTERNAL SPARKING BALL-POINT PEN WITH WIRE TO CARRY ELECTRICITY. GRAF CONSISTS OF TWO RIBBON CAPACITOR MICROPHONES PLACED AT RIGHT ANGLES; MAY BE MOUNTED ON ANY SYSTEM OR ~~SIDE~~ SET-UP. (WITH ON OFF MIKE SWITCH, MIKE CAN BE EITHER 11 OR 14 INCHES IN LENGTH) ~~ASSY~~ WIRE RUNS FROM MICROPHONE TO CONTROL BOX	$200 (DMA)
GP-2	CONTROL BOX CONTROLS SPARK PEN FUNCTION, AND RECEIVES MICROPHONE ~~DATA~~ INPUT DATA. ~~IT~~ OUTPUT AS BINARY DATA {~~NO~~ FOR BCD ADD $300}	$2800 (DMA)
RS-232	INTERFACE UNIT ~~GIVES IT~~ TAKES DATA FROM CONTROL BOX AND MAKES IT READABLE FOR TELETYPE.	$100 (DMA)
MOUNTING OF GRAF/PEN ON PLOTTER	LABOR COST	$100 OR LESS (DMA OR TSS)
PAPER ROLLER	LABOR AND PARTS ROLLS PAPER, ~~FROM~~ RENEWS CLEAN SHEET OF PAPER ~~TO USE~~ FOR DRAWING. CONSIST OF TWO CRANK AND SPOOLS FOR PAPER ROLL 10 TO 11 INCHES WIDED MOUNTED ONE ON EACH NARROW SIDE OF THE PLOTTER.	$25 (DONE LOCALLY)


RS-232
GP-2
WIRE FOR MICROPHONE
WIRE FOR PEN
SPARKING PEN
ROLLER
TSP 212
TTY

OPTIONAL IS A GOOD RELIABLE TELETYPE TERMINAL FOR ABOUT $3500. THE MODEL 33 TELETYPE WE HAVE ARE NOT VERY GOOD AND VERY UNRELIABLE. IN ADDITION THE NOISE LEVEL IS NOT SATISFACTORY OR CONDUCIVE TO LEARNING.

WHAT THIS SYSTEM HAS TO OFFER & IPLOTTER:

1) Complete machine control of presentation of material including capacity for storage of thousands of problems, access in continuous strings in any order
2) Exact placement of points and vectors regardless of movement equipment
3) Many students can run the same problem at the same time.
4) Problems can be changed easily.
5) No changes needed at the computer end of the telephone line.

UNIT ONE

PLOTTER: MFG & SALES: TSP CORP, TIME SHARE PERIPHERALS
MIRY BROOK RD.
DANBURY, CONN. 06810
203-743-7624

SALES CONTACT: EDWARD A. SCHAFER, JR.
ENGINEER CONTACT: MICHAEL P. TAYLOR

MODEL TSP 212: . PLOTTER ON TABLE, WITH INTERFACE FOR TELETYPE BUILT IN, COMPLETE WITH CABLES. NO OTHER EQUIPMENT NEEDED, NO MODIFICATION TO TIME SHARING SYSTEM NEEDED, NO SERVICE CONTRACT REQUIRED OR GIVEN, PROGRAMS & ROUTINES SUPPLIED FOR VARIOUS FUNCTIONS.

COST $3300 COMPLETE.

DISADVANTAGES: COST. 3300 DOLLARS.

ADVANTAGES: COMPLETE MACHINE CONTROL OF PRESENTATION OF MATERIAL INCLUDING. CAPACITY FOR STORAGE OF THOUSANDS OF PROBLEMS. ACCESS IN CONTINUOUS STRINGS IN ANY ORDER; GIVING RISE TO PROGRAMMED LEARNING BY MACHINE EVALUATION.

EXACT PLACEMENT OF POINTS AND VECTORS REGARDLES OF MOVEMENT OF EQUIPMENT

MANY STUDENT CAN USE THE SAME PROGRAM EVEN THOUGH BRANCHING MAY VARY DUE TO ANSWER DIFFERENCES.

EASY CHANGE OF ~~OF ANSWERS OR~~ PROBLEMS OR ADDITION OF PROBLEMS

NO CHANGES NEED TO PRESENT TTY EQUIPMENT (SAVE ~~ADDING A~~ ATTACHING A COUPLE WIRES

NO CHANGES TO TELEPHONE OR COMPUTER SYSTEM.

P6

UNIT TWO

GRAF/PEN (TM)

MFG. SCIENCE ACCESSORIES CORPORATION
65 STATION STREET
SOUTH PORT, CONNECTICUT 06490
203-255-1526

MARKETING CONTACT: ROLF KATES
SALES REPS: MR. MICHAEL GUTMAN
MR. ED KING ← HAS VISITED
P.O. BOX 309
SUDBURY, MASS. 01776
617 890-7148

Cost 4000 with extras included

Disadvantages: Several parts to pen system

Advantages: Can be mounted on the plotter a little extra expense giving a set-up that will receive and send graphic information. (The two units plug into the teletype.) No datapoints

The Advantages of the Plotter-teletype-terminal system

The system is the most ideal for these reasons.

1) It allows the student subject to be totally free of an advisor once the student subject has seen, ~~the entire~~ how to control the instrument. Therefore outside influence is ~~minimized~~ removed during testing.

2) The plotter enables the program to move on to more advanced problems once the student subject begins to get a continuous string of problems correct. Therefore reduction of the chance of ~~loosing interest~~ disinterest in working with the program.

3) the "graF/Pen" allows input of points, lines, or other graphical data by student subject.

4) the teletype is used for giving instructions for problems, and receiving alphanumeric data. ~~data is used for transmission to telephone of coded data.~~ Also coded data is passed through the teletype to the telephone and computer

5) Paper roller is used to change to blank sheets of paper after every problem. alternative is using individual sheets of paper.

6) Mounting of the "pen/pen" microphone on the plotter is required to that student subject can work on the problem sheet.

7) Reason for plotter over other plotters
A) works faster than other types of displays found at average input speed of 10 cycles per second. B) Requires no modification of existing equipment. ~~C) Does not require~~ C) A number of Programming routines for computer come with the unit at no extra charge. ~~D)~~
D) The unit is self contained. E) Recommended by Tom Kurtz, of Dartmouth, who said it was the best buy today in his opinion, was better than other units he had seen because of speed, reliability, ~~self contained~~, self containment, and price for a unit with its features.
E) Regional factory, if repairs are ever needed.

check name should be on one that was at NEC Summer two weeks ago

5) Reasons for 'Data/pen' over other pens.
A) other pens need a matched display and these displays all run with our accessories including required modifications to present computers system.
B) May be used in modified situations.
C) Does not need points exactly pre-positioned as light pen does. (FOR EXAMPLE WITH A LIGHT PEN THE SCREEN MUST HAVE DOTS ~~ON THE SCREEN~~ PRESENT TO REGISTER THE IMPULSE IN THE COMPUTER
D) SYSTEM IS CHEAPER THAN SYSTEM USING JOYSTICK. (TEKTRONIC JOY STICK REQUIRES SYSTEM WHICH IS QUOTE TO BE IN THE AREA OF $15,000.00)

Alternative set up #1

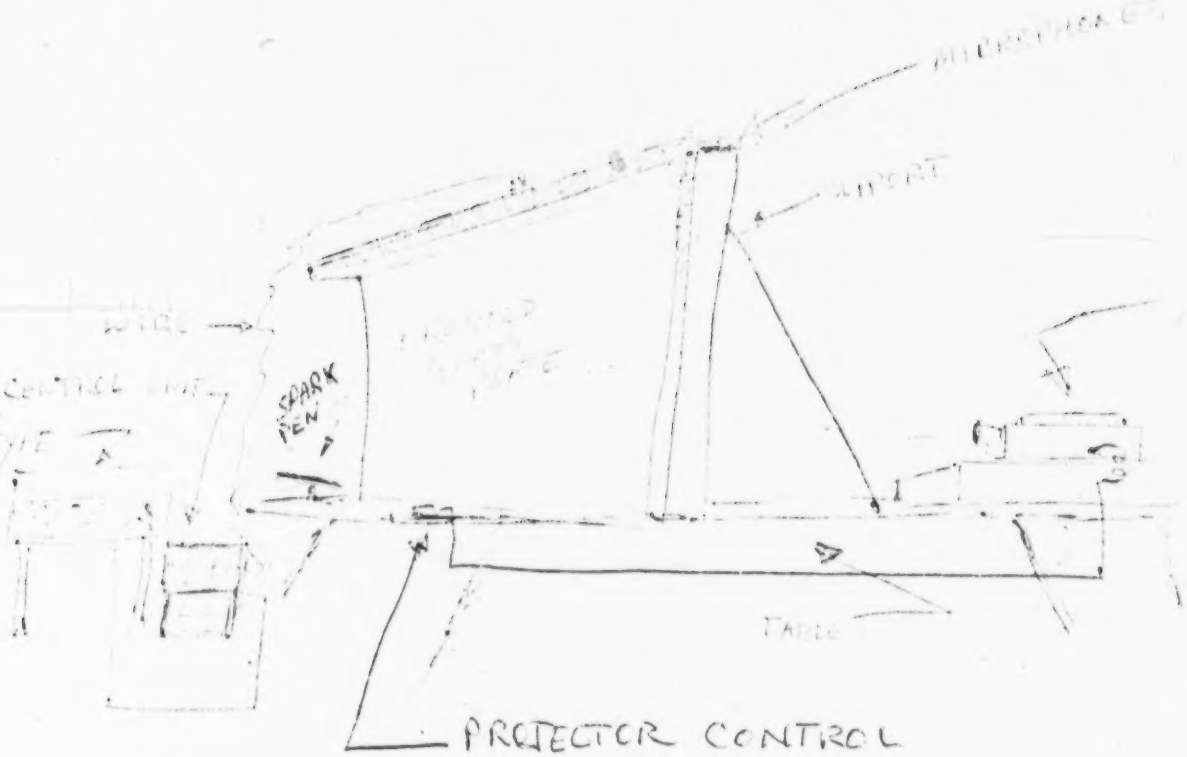
Use of "graF/PEN" mounted on frosted glass plate. Slide projector showing slides of problems with remote control switch.

Advantage is less cost due to the saving of the cost of paper, pen and plotter.
More text could be given (instructions) per unit time.
Cost ~~$4000.~~ for 'graF/pen' and related accessories.
Cost of projector
Cost of staging for equipment
Cost of film production

Terminal would still be needed for input of data.

Disadvantages. Problems would be in set order and limited to the set of slides order. Any arrangement to a predetermined point after a series of right answers, would have to be done by the student or an advisor; if done by computer, a homemade device would have to be constructed. Also would need to make a device that would cover answer until the proper time.

P-11



PROJECTOR CONTROL

Ted Hommel

GRAF/PEN

Two uses for the "graf/pen"

1) The "graf/pen" can be used to present graphical input to be used with a plotter. This would be as a programmer's aid. Many shpaes can not be described by a mathematical equation and would require a programmer to draw the shapes on a large piece of graph paper and then record all the coordinates. The time using graph paper would be tens of hours for anything but the simplest drawing. The same done by a "graf/pen" would be ten to twenty minutes (that includes set-up time).

2) The "graf/pen" can be used by students to mark answers and solutions on graphical material, have their answer evaluated by the computer, and the evaluation typed on the terminal next to the "graf/pen" unit. The student would need to push the return key (or something that would send the return key code) to signal the computer that the answer is ready for evaluation.

The computer would not be needed to present material because the "graf/pen" microphones can be mounted on frosted glass allowing projection of material from behind. The best arrangement is to use a plotter and the graf/pen together. This allows the student to work almost non-verbally with the computer. The computer presents the material with the plotter and the student answers with the graf/pen.

Three programs were written to evaluate the graf/pen. One program repeated the patterns drawn on the graf/pen tablet. Two others evaluated points. Of those two, one evaluated a square tarfet of three areas (ie) and one evaluated a round target (ie).

GRAF/PEN

The second of the two allcwed a choice of the number of boundaries. Both allowed the target to be moved and the boundaries to include any specified area.